Motorship

Registered in U. S. Patent Office and abroad

30-In. Hydraulic Dredge, CLACKAMAS

Designed, constructed and equipped by the Port of Portland, Ore. under direction of James H. Polhemus, Genl. Mgr.

Built as the world's largest —now a remarkable record holder

THE CLACKAMAS has had eighteen months' steady service. A steam-engine and a steam-turbine-driven dredge with same diameter delivery line were engaged on the same work during this time.

The CLACKAMAS operated more pumping hours than either, handled heavier material through longer line, and delivered almost as great yardage as both steam outfits together—yet was cheapest to operate and free from mechanical and operating troubles.

The CLACKAMAS operates entirely on power from four

McINTOSH & SEYMOUR DIESEL ENGINES

McINTOSH & SEYMOUR CORPORATION, AUBURN, N. Y.

MAR., 1927

PRICE 35c.

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Volume XII March, 1927 *Number 3*

Packet Service and Express Tramping with 400-Ton Fast Freighter

New Ideas in Water Transportation Exemplified in the Coastwise Operation Between the Delaware and the Hudson of the Philadelphia Packet Line's Small Freighter Eckmuhl

MAINTENANCE of a 24-hr. schedule for package freight between Philadelphia and New York is planned by the Philadelphia Packet Line, which is now operating the ms. ECKMUHL of 400 tons d.w. coastwise between the Delaware and the Hudson.

This efficient little packet demonstrates the feasibility of the 24-hr. schedule. Repeatedly she makes the run between the Battery in New York and the foot of Chestnut St., Philadelphia, in 21-hr.—23-hr. Since she was placed on the service in November, she has logged the 117 miles between the Scotland lightship and the Overfalls lightvessel in 12-hr. time after time in all weathers with only a few minutes variation. The differences in the total elapsed time between the two cities are due to the influence of the tide on the river passage between Philadelphia and the Delaware Breakwater, this tide not being neutralized like the coastwise tide is during the even 12-hr. run from light to light. The adverse effect of the tide in the Delaware is never sufficient, however, to prevent the ECKMUHL tying up at either terminal less than 24 hr. after she has cast off from the terminal at the other end of the journey.

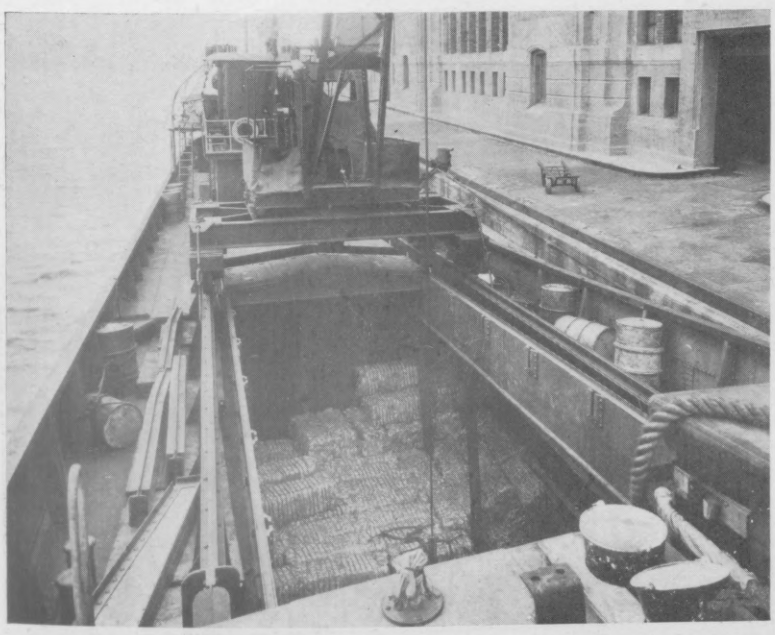
A 24-hr. packet service between these two Eastern cities will afford the opportunity

Packet motorfreighter Eckmuhl

for trucks to deliver freight on the pier in the morning with the assurance that it can be picked up by truck in the other city the next afternoon. Ordinarily such despatch is entitled to the term express service. The only system that can beat it in point of time is inter-city trucking, which is so expensive that it can be justified only by valuable commodities.

ECKMUHL can carry about 400 tons of cargo. To load and discharge she has a luffing crane which handles between 30 tons and 60 tons per hour, depending on the nature of the freight. The faster rate is with weight cargo and the slower rate with measurement cargo, so that really the average time for loading or discharging is about 6 hr. or 7 hr. when the freight moves quickly across the pier. A measurement cargo fills the hold more rapidly than the weight cargo, of course, ton for ton.

Alone, the ECKMUHL cannot initiate the regular packet service between Philadelphia and New York, because she can make a sailing from each of the two ports only once every 4 days. If another packet could be put on the berth a sailing could be given from both ports on alternate days. To give a daily schedule in both directions



Hatch and girder arrangement in hold

Eckmuhl's crane handling package cargo

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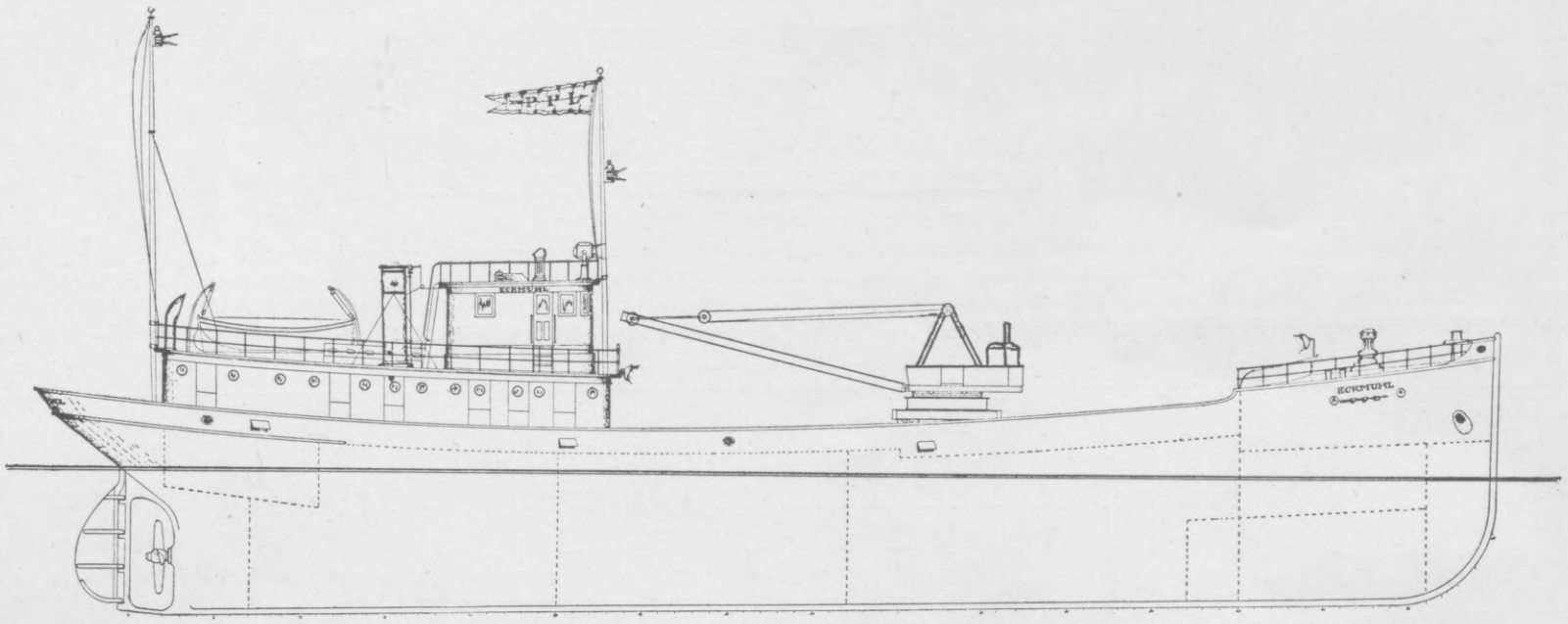


Ms. Eckmuhl, fast Diesel driven packet freighter, is a converted steamer built as a trawler for the French government

would need four ECKMUHLS in service.

In the interim this weatherly and able little coaster has many customers to whom she is giving exceptionally good service. For instance, she often loads at the Du Pont pier near Wilmington, Del., an export shipment for a fast vessel sailing out of New York, maybe a Dollar liner. ECKMUHL can go alongside the vessel in New York, and the entire shipment will be in the liner's hold within 36 hours of the time she pulled away from the Du Pont pier. Contrast that with the service that can be expected on, say, eight or nine carloads routed by rail from Wilmington, Del., to Brooklyn, N. Y., with the switching yards at Philadelphia and at tidewater New York in between, plus lighterage by the railroad company across the bay at New York and possibly switching in Brooklyn.

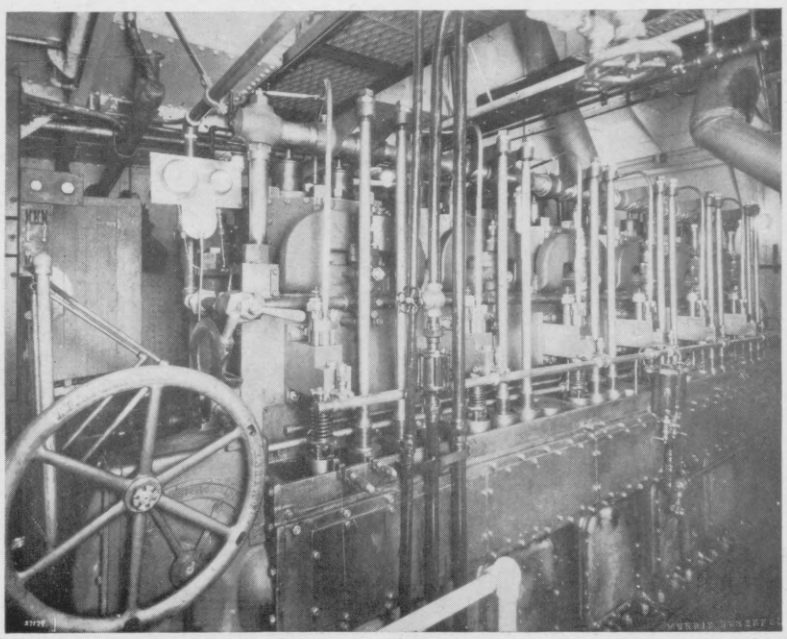
Another example of the express tramping which ECKMUHL is now doing can be found in the shipments she takes from vessels arriving in New York with small tonnages for Philadelphia. Usually a shipping company will divert a vessel to a port en route for a shipment of 500 tons. For a good customer they will shade the figure to 400 tons, but they scarcely ever go below that figure. The Bank Line motorships from the Far East often come into New York with small shipments for Philadelphia—250 tons of jute, for instance. The ECKMUHL can go alongside the Bank Liner, load the Philadelphia cargo as it is swung over the ship's side and discharge it on the pier in Philadelphia at much less cost to the Bank Line than the diversion of the ship would entail.

In the transshipment of cargo for the shipping companies in direct shipments from factory pier to steamers or branch warehouses in the other port, in transfers between open or bonded warehouses in Philadelphia and New York, and in similar handling of bulk lots the ECKMUHL is demonstrating the judgment of her sponsors to be correct, in that they recognized how the efficiency and special advantages of the Diesel engine can assure the profitable operation of relatively small and relatively fast freighters.

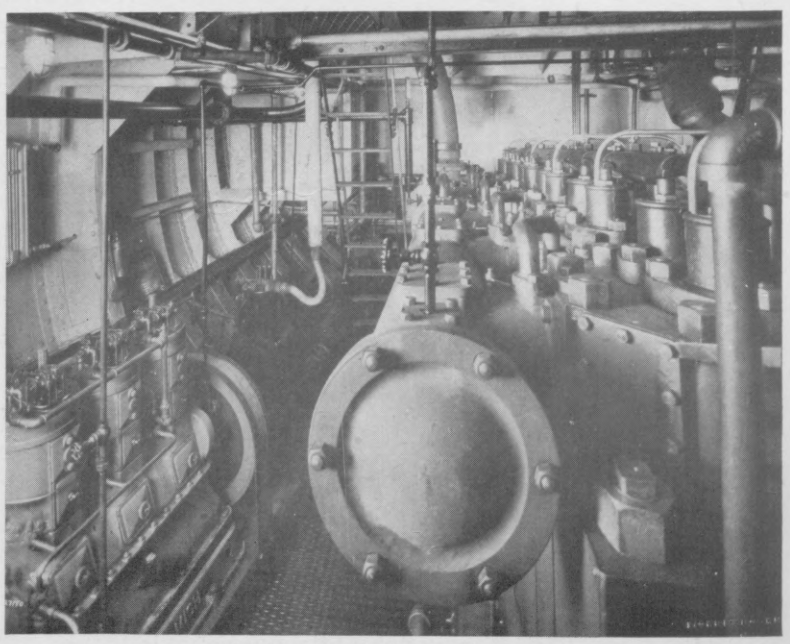
There is no regular steamer service between Philadelphia and New York. The distance by water is about 220 miles or 255 statute miles: by rail or road it is about 85 miles. Where the opportunity exists for the ECKMUHL has just been illustrated by several examples. She can make 10 knots good with her engine turning at 208-212 r.p.m. and she can do it in any weather. Her port to port run is safely inside the 24-hr. limit.

In two such centers of shipping as New York and Philadelphia there are many zones more favorably situated for water transportation than for railroad connections, and many industrial zones are similarly situated. If these zones are offered a 24-hr. packet service between the cities it is better than they can secure by railroad, and since freight has to be trucked to ship pier and to railroad freight yard alike the problem of the collection and distribution remains the same for the shipper in both cases. What the packet service can do is therefore to improve and expedite shipment within certain zones.

ECKMUHL has been converted from a steam trawler. She is one of a fleet of such vessels ordered in this country by the French Government during the war. She was built at Savannah, Ga., and having been completed only in 1919 was never taken over by the French, but was sold here and laid up after she had made her contract trial trip. She is the type of ves-



Main 450 hp. engine showing control



Starboard side of engine room

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sel used by the French fishing companies for trawling anywhere between Morocco and Iceland, a type that can not only stay at sea when other vessels of her size are running for shelter but will keep her trawl down in such weather too.

Characteristics of mv. Eckmuhl

Length overall	150.0 feet
Length b.p.	139.4 feet
Registered breadth	25.2 feet
Registered depth	14.2 feet
Deadweight capacity	400 tons
Engine power	450 b.hp.
Service speed loaded	10 knots

Plans for her conversion were drawn out by M. C. Furstenau, naval architect, Philadelphia, who developed her into the excellent freighter she has proved to be. The former boiler room, bunker and refrigerated fish hold have become the two cargo holds, with hatches respectively 35 ft. and 21 ft. long and both 11 ft. 8 in. wide. A deep girder has been added fore and aft alongside the hatch coamings for the full length of the hatches on both sides, adding strength to the deck and serving for the rail tracks of the locomotive type crane used for cargo handling. Nearly all the space in the fo'c's'le can be used for general freight and the part deck below is used for small consignments of bonded freight. (The vessel has a Customs license for carrying bonded freight to her full capacity).

Abaft the holds are the machinery space and the living quarters. The engine room is very compactly arranged. The layout represents the combined efforts of M. C. Furstenau and of the Kensington Yard of the Wm. Cramp Ship & Engine Bldg. Co., to which the work of conversion was entrusted.

In this space are grouped the 450 b.hp. Nelseco airless injection engine for propulsion, the 18 hp. Hill auxiliary engine driving a 12 kw. generator and a Rix air compressor, the Delco 2½ kw. generator set—now adjusted to run better on gas oil than it did on kerosene—the electric fire and bilge pump, the reserve lub. oil pump, maneuvering air flasks, switchboard, Frigidaire, workbench, heating boiler, fresh water tanks, lub. oil tanks, fuel oil service tank and minor pumps. Yet so well has this machinery been laid out that space in the engine-room is not cramped.

The main item of this machinery equipment and the item that has secured the successful performance of the ECKMUHL is the 450 b.hp. 6-cyl. Nelseco engine of the airless-injection type which the New London Ship & Engine Co. has been building the last two years. The type was described in MOTORSHIP, August, 1925. It represents the latest achievement of the Augsburg engineers of the M.A.N. who have been constantly improving the Diesel engine since they commercialized the design of Dr. Diesel's invention and built the first one for him to operate successfully 30 years ago.

This new style Nelseco airless-injection engine operates with a perfectly clear exhaust, demonstrating that it burns completely all the oil injected into the cylinders. It follows that with such complete combustion and no air injection compressor to absorb power, the fuel economy of the engine must be low. This shows itself in all the brake tests, these engines all recording less than 0.4 lb. per b.hp.-hr., which for relatively low powered engines of moderate speed is an unusually low figure.

Operating at 208-212 r.p.m. this engine consumes about $28 worth of fuel on the passage between Philadelphia and New York, equivalent with a full cargo to about 2¾ cents per 100 ton miles.

Air being needed only for starting and maneuvering the compressor is entirely auxiliary. It is installed at the forward end of the engine and is a Norwalk 3-stage machine driven through clutch and gears from the main engine shaft. It charges four flasks of 40 cu. ft. capacity at 1000 lb. per sq. in. Most of the time the vessel is under way the compressor is declutched and imposes no load on the engine. The water circulation pump, lub. oil pump and fuel oil transfer pump are driven by a transverse shaft at the forward end of the engine, the f. o. transfer pump running with a by-pass except when the service tank has to be filled.

In normal operation the engine is thus a self-contained unit, not requiring any auxiliaries to be kept running for her service. There is of course a reserve equipment: a hand pump for the fuel oil transfer, a Worthington rotary driven by a Diehl enclosed motor with C. H. starter for the lub. oil, and the Morris centrifugal fire and bilge pump driven by a G. E. motor for the water circulation.

Fuel is stored in two tanks forward, with capacities of 5000 gal. and 8500 gal. respectively, equivalent to about 6,000 miles endurance at 10 knots. This capacity enables ECKMUHL to operate for long periods without losing time for bunkering. Similarly she has large fresh water capacity for the crew's use, carrying a total of about 4000 gal. in the after peak tank and in two tanks in the engine room. With about 180 cu. ft. capacity of ice-box served by a Frigidaire unit she could therefore make long passages.

Her accommodation is arranged on the lower deck abaft the engine casing and in the deckhouse, where the galley and messroom also are located. Heating is provided from the small boiler in the engine room.

Recognizing that rapid handling of the cargo at the terminals is needed not only to give quick service to customers but also in order to reduce the dead time of the vessel the Philadelphia Packet Line decided to equip the ECKMUHL with a locomotive type crane. They selected for this purpose a standard Brown hoist creeper crane of the gasoline engined type, removed the creeper trucks and mounted the machine on rails laid on the girders previously mentioned as having been added alongside the hatch coamings. The height of these rails gives the crane clearance over the hatch covers. The cab has been removed because it restricted the vision of the operator, and when the crane is not in operation a tarpaulin is lashed over the machinery to protect it from the weather.

This crane has a capacity of 2 tons at full radius of 30 ft. and can lift 5 tons at short radius. The engine is about 40 hp. The operator obtains a clear view of the hold all the time, and at most piers at all heights of tide can see his load on the dock. He can therefore operate quickly and safely. During ECKMUHL'S first three months of service the crane has been operated 290 hr. to the entire satisfaction of the owners, and has proved a very efficient unit.

European Motor "Coaster" in B. C. Waters

Ms. HURRY ON, 950 ton motorship owned by John Dalziel of Glasgow, operating on the British Columbia coast in the coastwide trade is a type of ship upon which the conversion characteristics of Ms. ECKMUHL may be said to be based.

specially reinforced forward to contend with ice, though her ice breaking abilities are not likely to be tested on the Canadian Pacific coast unless she is sent to the Arctic.

She is equipped with a 4-cylinder Sulzer Diesel developing 420 s.hp. at 200 r.p.m., which is said to drive her at just over 9 knots running light, a speed of about 8½ knots having been maintained on the run

Motor "Coaster" Hurry On is a type of ship comparable with Eckmuhl

Built in Germany in 1923, she was formerly known as the OSWIGO, the builders being Norddeutsche Unionwerke. Her dimensions are 173 ft. length, 29.4 ft. breadth mld, about 950 tons deadweight capacity and 645 tons gross. She was built for the Baltic Sea trade and is across the Atlantic. The engine room auxiliaries are electric.

HURRY ON'S former fuel capacity was small on account of being engaged in coastwise trade, but before leaving Antwerp her double bottoms were fitted for oil tanks, and she now has a capacity of 170 tons.

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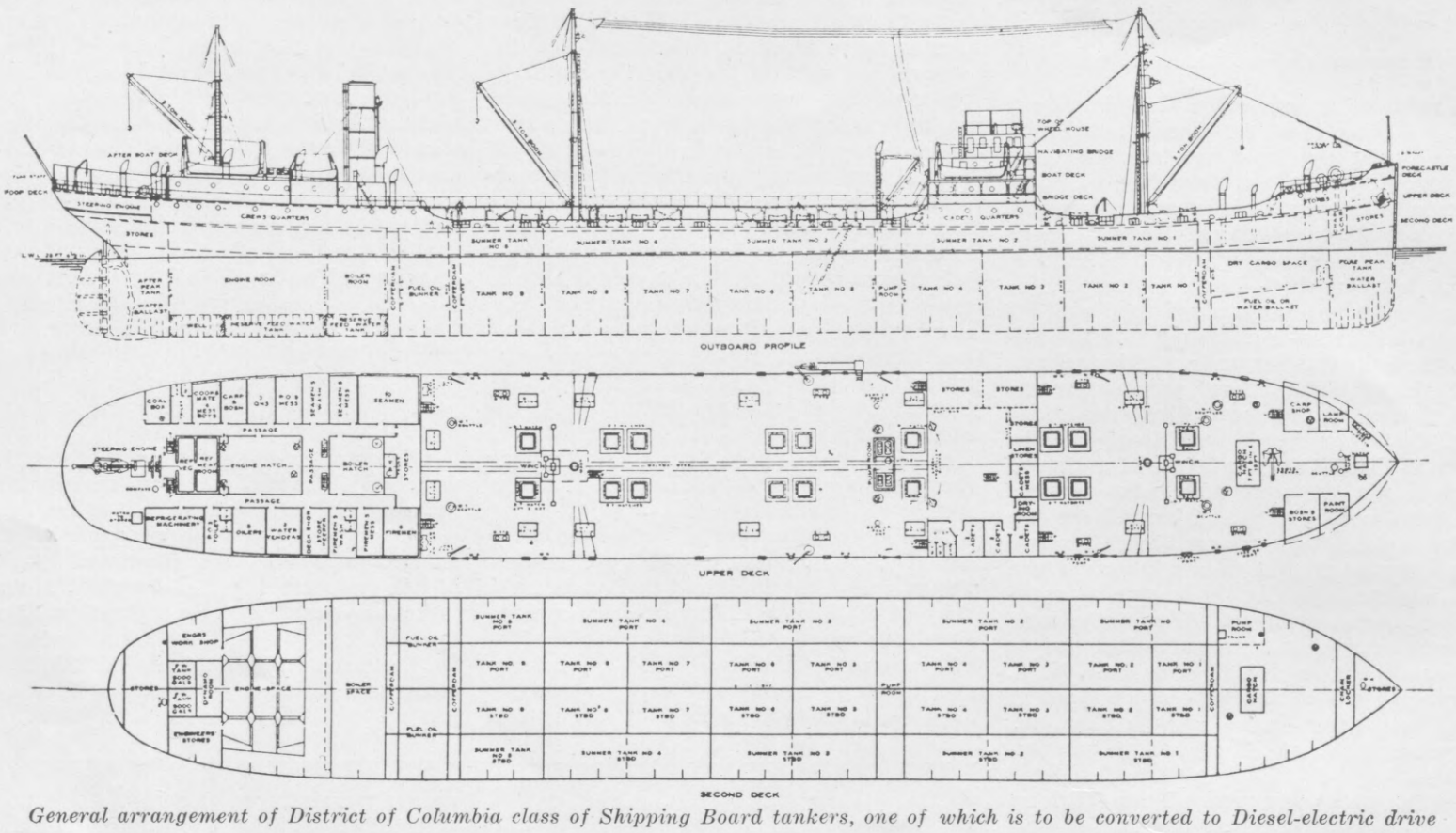
World's Largest Diesel-electric Ship

Standard Oil Co. of California to Modernize 10,000-ton Tanker District of Columbia by Removing Steam Plant

MS. DISTRICT OF COLUMBIA when converted from steam drive, which she has at present, to Diesel-electric drive will be the largest ship with this type of propulsion in existence. Her present steam turbine machinery will be torn out and the whole of the machinery space remodelled to take four Busch-Sulzer Diesels each of 1100 b.hp. rating at 275 r.p.m. These are of a new and special Busch-Sulzer design and are of single-acting 2-cycle trunk piston type. Each engine will be direct coupled to a generator and exciter and the whole of the generating sets will supply current for a main propelling motor and for the whole of the auxiliary machinery on the ship.



General arrangement of District of Columbia class of Shipping Board tankers, one of which is to be converted to Diesel-electric drive

District of Columbia Characteristics

Length b.p.	430 ft. 0 in.
Length overall	450 ft. 0 in.
Beam, molded	59 ft. 0 in.
Depth, molded	33 ft. 3 in.
Draft (load)	25 ft. 4¼ in.
Displacement (load)	14,760 tons
Block coefficient	0.802
Capacity main tanks	72,670 bbl.
Capacity summer tanks	10,476 bbl.
Cargo (hold and 'tween decks)	35,883 cu. ft.
Deadweight tonnage	10,250 tons
Type of construction	longitudinal

The ship is one of a class of three ships their names being respectively DISTRICT OF COLUMBIA, TUXPANOIL, and TULSAGAS. The TUXPANOIL is already slated for conversion to Diesel drive and will have Falk engines and gears. These vessels are thoroughly well constructed and up to date bulk oil freighters in every respect, except for their existing propelling machinery. They are constructed on the longitudinal system of framing and have nine double tanks with summer tanks. There is a short topgallant forecastle, and a bridge structure amidships containing quarters for the deck officers. The pump room is arranged between nos. 4 and 5 tanks and its entrance is just abaft the bridge structure.

Three More S. B. Conversions

ALLOCATION of contracts to fit Diesel engines in the Shipping Board freighters WEST GRAMA, YOMACHICHI, and SEMINOLE will see the completion of the conversion of the first group of 12 ships contemplated by the Board measurably within distance. On February 15 bids were opened by the Division of Maintenance and Repairs, 45 Broadway, New York, for the Dieselization of the three ships above named.

Latest U. S. S. B. Conversion Bids

COMPANY	SHIPS	PRICE
Bethlehem	West Grama	$575,000
Morse D. D.	Seminole	625,000
Newport News	Yomachichi	527,500
Staten Is. Sb	Seminole	675,000
Tietjen & Lang	Seminole	579,590
	West Grama	619,420

SEMINOLE is to be equipped with a Hooven-Owens-Rentschler double-acting 2-cycle engine. YOMACHICHI with a Busch-Sulzer engine, and WEST GRAMA with a McIntosh & Seymour double-acting 4-cycle engine.

Work on the SAWOKLA, CITY OF RAYVILLE and CITY OF DAHLHART at Newport News is progressing smoothly, and it is hoped to have the former ready for her trials very soon, the others to follow shortly after.

This leaves one ship to complete the fleet of twelve. It is understood that this vessel will be selected shortly and that she will be fitted with a M.A.N. double-acting 2-cycle type Diesel engine built by the New London Ship and Engine Company.

Sun Shipyard Busy

Sun Sb. Co., Chester, Pa., is at the present time very active in motorship construction. Construction work in the shipyard will shortly be proceeding on a 13,300 ton, 3000 s.hp. 11½ knot tanker to be propelled by Sun-Doxford engines, while an order has recently been booked for a 15,000 ton tanker which will be equipped with a 6-cylinder 4000 s.hp. Sun-Doxford Diesel. Two large engines of similar type are under construction in the shops of similar size to the main engines of Ms. EAST INDIAN. Several small tankers and oil barges propelled by Diesel engines have been delivered and are on hand.

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Economy of Portland's Big Diesel Dredge

Year's Operation of World's Largest Diesel-electric Dredge Shows That Cheapness of Operation Is One of Her Principal Virtues

By James H. Polhemus*

THE Port of Portland, Ore., has a 30-in. Diesel-electric dredge CLACKAMAS which has now been in continuous operation since September, 1925; i. e. for somewhat over a year, and during this time has given every satisfaction, in addition to proving a most economical unit. The construction and arrangement of the vessel were described in some detail in the October 1925 issue of MOTORSHIP.

Although CLACKAMAS is Portland's largest and most powerful dredge, it is the cheapest to operate due to the economies which the Diesel engines permit. During the period which has elapsed since its commissioning, the vessel due to its power, simplicity, and flexibility of design has performed the cheapest and most difficult work of any of the port's dredges.

A synopsis of the working time and the yardage output of this dredge to date of writing is shown in Table A below:

TABLE A

Work Done by the Dredge Clackamas Since Going Into Commission

Month	Material Removed Cu. Yd.	Net Terminal Lift Ft.	Pipe Line Length Ft.	Pumping Hrs.	Operating Days.
1925					
Sep.	413,230	29.1	6273	433	25
Oct.	855,540	29.7	4967	495	26
Nov.	426,075	31.0	5619	488	24
Dec.	448,820	28.6	4887	569	26
1926					
Jan.	615,990	28.9	4564	546	26
Feb.	467,800	25.1	6601	448	24
March	504,350	29.3	5988	573	27
April	337,580	28.5	7085	554	26
May	394,260	24.5	6288	503	25
June	152,500	27.6	3904	150	8
July	755,320	29.9	3923	510	26
Aug.	1,027,250	31.8	2601	522	27
Sep.	548,440	31.6	4229	499	25
Oct.	659,990	30.5	3585	528	26
Nov.	364,835	28.0	4114	483	24

As The Port of Portland's cost and operating records are kept on a fiscal year basis, ending Nov. 30 of each year, we shall analyze the record of the Dredge CLACKAMAS for the last fiscal year, ending November 30, 1926.

A comparison of the work done by CLACKAMAS and two of the 30 in. hydraulic pipe line dredges of different power ratings, operated by The Port of Portland during the fiscal year, 1926, is shown in Table B, the cost figures in which are based on burning fuel oil at $1.30 per bbl. on the steam dredges, although as a matter of fact we burned a cheaper fuel, commonly known in this district as "hog fuel." It is saw-dust and chopped saw mill waste, a by-product of the numerous large lumber mills located in the city of Portland and vicinity.

Dredge COLUMBIA has a 4-cylinder 1200 s.hp. triple expansion engine for driving the dredge pump. TUALATIN'S dredge pump is driven through reduction gears by twin turbines of 2000 total s.hp., while CLACKAMAS has a 2700 hp. Westinghouse electric motor driving the dredge pump.

From the above comparisons it is apparent that the CLACKAMAS is quite as reliable and sturdy a dredge as the steam dredges, and it is especially noticeable that she got in more pumping hours during the year than any of the others. Dredge COLUMBIA was taken out of service for 2½ months and the CLACKAMAS 3 weeks for biennial overhauling. TUALATIN had just been given its biennial overhauling before the start of the fiscal year.

It will be noted also that CLACKAMAS had a much longer average pipe line, did more dredging and, more important still, carried it out more cheaply. This dredge without the aid of a booster successfully pumped through pipe lines 8600 ft. in length against a net terminal lift of 30 ft. for short periods.

The material handled by the dredges under discussion was a heavy sharp sand in most cases, but some gravel and clay was encountered. For all practical purposes all the dredges shown in Table B were called upon to do the same class of work during the year, but the length of pipe lines varied, the lower powered dredges being confined to the shorter pipe lines. With dredges of similar type operating in the same class of material and pumping through pipe lines not exceeding the length for which their pumps were designed, the output will be greater for the higher powered dredges within certain limits. Long pipe lines of course increase the pumping head and consequently require more power at the pump. Very heavy materials require greater pump power even for the relative short pipe lines. CLACKAMAS has clearly demonstrated that she can do very successful work in heavy material on long pipe lines where similar sized dredges of less power could not be operated with any results whatever.

The costs given are the out of pocket costs for which the Port of Portland had to raise money to operate these dredges. They do not include any overhead, depreciation, or interest charges and, therefore, are given for comparative purposes as between our

TABLE C

Comparison of Work by Diesel and Steam Dredges on Long Pipe Line Work

Dredge Clackamas

Date	Cu. Yds. Dredged	Pipe Line Vac.	Pipe Line Press.	Net Term. Lift	Length of Pipe Line	Pump Impeller Diameter	Pump R.P.M.
Nov. 9	12,320	15 in.	80 lb.	30 ft.	5960 ft.	70 in.	321
Nov. 10	15,400	14 in.	83 lb.	30 ft.	5960 ft.	70 in.	326
Nov. 12	9,240	15 in.	80 lb.	30 ft.	4830 ft.	70 in.	320
SUB-TOTAL	36,960 cu. yds.						

Cost at $715 per day, $2145. Cost per cu. yd., $0.058.

Dredge Tualatin

Jan. 1	9,000	11 in.	56 lb.	30 ft.	5785 ft.	69 in.	290
Jan. 2	8,800	12 in.	58 lb.	30 ft.	5745 ft.	69 in.	290
Jan. 3	8,500	11 in.	58 lb.	30 ft.	5745 ft.	69 in.	290
SUB-TOTAL	26,300 cu. yds.						

Cost at $657 per day, $1971. Cost per cu. yd., $0.075.*

* Using oil fuel in place of hogged wood the TUALATIN'S cost per cu. yd. would be $.095 on the basis of 27 percent increase in total operating cost.

TABLE B

Comparative Dredging Record for Two Steam Dredges and Diesel-Electric Dredge

Dredge	Rated Pumping S.hp.	Cu. Yd. Dredged	Net Terminal Lift	Pipe Line Length	Transport Units *	Total Pumping Hours	Total Cost of Operation	Cost Per Cu. Yd.	Cost Per Trs. Unit	Cost Per Pumping Hp. Year
Columbia ...	1200	3,645,635	27.4 ft.	3765 ft.	165,209	4127	$216,810.66	$0.06	$1.31	$180.68
Tualatin ...	2000	2,818,900	25.6 ft.	3973 ft.	131,024	5405	221,784.43	0.08	1.69	110.89
Clackamas .	2700	6,277,135	28.9 ft.	4808 ft.	380,385	5932	206,799.00	0.03	0.54	76.00

*The term "transport unit" is used to designate a unit used as a basis of comparison. A transport unit is 1000 cu. yd. pumped through 100 ft. of pipe line. One foot of net terminal lift is equivalent to 50 ft. of 30 in. pipe line. By transposing all dredge output to transport units, we equalize, for purposes of comparing costs, the variation in pumping head between short and long pipe line dredging.

*Engineer Port of Portland Commission.

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One Year's Operation Cost for Diesel-electric Dredge Clackamas

TABLE D

Recapitulated Summary of Operating and Maintenance Costs

Total Expenditures

Items	Dredge Willamette		Dredge Columbia		Dredge Tualatin		Dredge Clackamas	
Period	Jan. 1, 1922 July 31, 1926	Per cent of Total	Jan. 1, 1922 July 31, 1926	Per cent of Total	Jan. 1, 1922 July 31, 1926	Per cent of Total	Aug. 17, 1925 July 31, 1926	Per cent of Total
Operation								
Labor (operating)	$190,003.87	0.290	$197,739.22	0.286	$204,021.23	0.257	$50,732.44	0.259
Fuel and water	67,712.64	0.103	84,200.29	0.122	130,061.48	0.164	30,678.71	0.157
Engineer department supplies	14,471.59	0.022	14,792.15	0.021	9,446.23	0.012	14,408.25	0.074
Deck and miscellaneous supplies	10,592.98	0.016	13,107.64	0.019	10,215.14	0.013	2,933.50	0.015
Auxiliary operation	63,516.51	0.097	63,893.29	0.092	87,150.33	0.110	7,927.80	0.040
Subsistence	44,422.03	0.068	46,321.73	0.067	47,000.50	0.059	10,900.22	0.056
Insurance	37,685.51	0.057	57,549.60	0.033	44,096.82	0.056	14,100.01	0.072
Sub-total (operation)	$428,405.13	0.653	$477,603.92	0.640	$531,991.73	0.670	$131,680.93	0.672
Maintenance								
Cutting machinery	$31,884.64	0.049	$46,503.61	0.067	$21,824.44	0.027	$1,776.08	0.009
Hull pipe and fittings	17,602.35	0.027	11,957.96	0.017	20,684.19	0.026	927.41	0.005
Ground tackle	20,353.86	0.031	20,237.49	0.029	17,382.03	0.022	2,195.35	0.011
Dredging pump	50,749.16	0.077	65,774.83	0.095	69,425.51	0.087	24,117.84	0.123
Power plant and auxiliaries	54,959.43	0.084	36,363.80	0.053	79,343.08	0.100	26,239.99	0.133
Miscellaneous dredging plant	21,010.39	0.034	16,505.20	0.024	24,016.90	0.030	3,660.28	0.019
Hull and house	23,734.06	0.036	13,708.46	0.020	21,825.87	0.027	3,863.45	0.020
Miscellaneous supplies and labor	4,355.83	0.007	1,372.04	0.002	4,934.41	0.006	954.06	0.005
Insurance	2,797.83	0.004	1,442.14	0.002	2,928.88	0.004	566.02	0.003
Sub-total (maintenance)	$227,447.55	0.347	$213,865.53	0.309	$262,365.31	0.330	$64,300.48	0.328
Total operation and maintenance	$655,852.68		$691,469.45		$794,357.04		$195,981.41	
Booster operation	9,813.32		65,296.90		62,026.36			
Total All Items	$665,666.00		$756,766.35		$856,383.40		$195,981.41	
Performance								
No. of operating days	1,228		1,220		1,208		274	
Total cubic yards dredged	12,387,075		15,336,954		19,962,478		5,564,945	
No. cubic yards with booster	322,340		3,695,820		1,560,545			
Cubic yards per operating day	10,087		12,500		14,042		20,310	
Average length of pipe line	2,635		3,147		3,794		5,445	
Rated pump s.hp.	1,200		1,200		2,000		2,700	

TABLE E

Recapitulated Summary of Operating and Maintenance Costs
Unit Expenditures

	30 in. Steam Dredge Willamette		30 in. Steam Dredge Columbia		30 in. Steam Dredge Tualatin		30 in. Diesel-electric Dredge Clackamas	
Operation	Per Day	Per Cubic Yard	Per Day	Per Cubic Yard	Per Day	Per Cubic Yard	Per Day	Per Cubic Yard
Labor (operating)	$154.73	$0.01534	$161.16	$0.01289	$168.89	$0.01022	$185.15	$0.00912
Fuel and water	55.14	0.00547	68.62	0.00549	107.67	0.00652	111.97	0.00551
Engineer department supplies	11.78	0.00117	12.06	0.00096	7.82	0.00047	52.58	0.00259
Deck and miscellaneous supplies	8.63	0.00086	10.68	0.00085	8.45	0.00051	10.71	0.00053
Auxiliary operation	51.72	0.00513	52.07	0.00417	72.14	0.00437	28.93	0.00142
Subsistence	36.17	0.00359	37.75	0.00302	38.92	0.00235	39.78	0.00196
Insurance	30.69	0.00304	46.90	0.00375	36.50	0.00221	51.46	0.00253
Sub-total (operation)	$348.86	$0.03458	$389.25	$0.03114	$440.39	$0.02665	$480.59	$0.02366
Maintenance								
Cutting machinery	$25.96	$0.00257	$37.90	$0.00303	$18.07	$0.00109	$6.48	$0.00032
Hull pipe and fittings	14.33	0.00142	9.75	0.00078	17.13	0.00103	3.38	0.00017
Ground tackle	16.57	0.00164	16.49	0.00132	14.89	0.00087	8.01	0.00039
Dredging pump	41.32	0.00409	53.61	0.00429	57.47	0.00348	88.02	0.00433
Power plant and auxiliaries	44.76	0.00444	29.64	0.00237	65.68	0.00397	95.77	0.00472
Miscellaneous dredging plant	17.11	0.00169	13.45	0.00107	19.38	0.00120	13.36	0.00066
Hull and house	19.33	0.00192	11.17	0.00089	18.07	0.00109	14.10	0.00069
Miscellaneous supplies and labor	3.55	0.00035	1.12	0.00009	4.08	0.00025	3.48	0.00017
Insurance	2.28	0.00023	1.18	0.00009	2.42	0.00015	2.07	0.00010
Sub-total (maintenance)	$185.21	$0.01836	$174.30	$0.01394	$217.19	$0.01314	$234.67	$0.01155
Total Operation and Maintenance	$534.07	$0.05294	$563.55	$0.04508	$657.58	$0.03979	$715.26	$0.03521
Booster operation		0.03044		0.01766		0.03975		
Total all items		$0.05374		$0.04934		$0.04290		$0.03521

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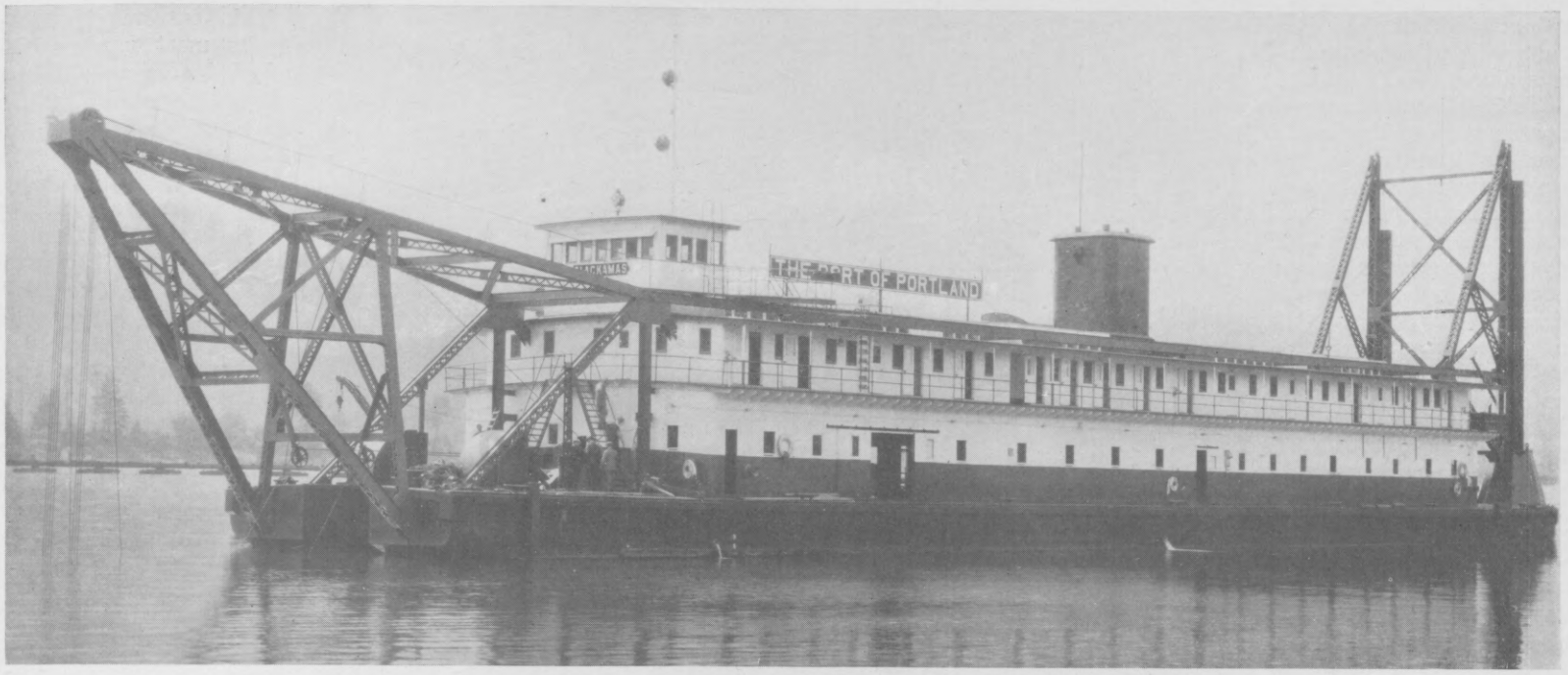

Diesel-electric Dredge Clackamas, owned by the Port of Portland, which has shown complete superiority over steam dredges in one year's work

dredges only and do not include the cost of any shore work. If we were figuring costs for doing contract work the totals would have to be at least doubled and possibly trebled, depending upon the volume of steady work done over which the more or less fixed upkeep costs could be spread. A successful contractor must also set aside a considerable sum on each contract to protect him against contingencies and losses, which he is bound to encounter on certain dredging projects. The purpose of this article therefore is not to find fault or criticize in any way the present day dredging contract prices. However, our out of pocket operating costs are the only ones we can draw upon for a true comparison as to the relative economy of the various dredges which The Port of Portland operates.

A direct comparison of what can be expected of the dredges CLACKAMAS and TUALATIN on long pipe line work, pumping heavy pea gravel, is shown in Table C. Three typical average days have been taken for each dredge working under identical operating conditions.

The Port of Portland has owned and operated large hydraulic pipe line dredges continuously since 1898. These dredges have been designed, built, and operated by the Port's own organization. The larger and finer dredges have been a gradual development to meet the special dredging requirements of the Port. The work of creating and maintaining an adequate channel has been essential to Portland and has been entrusted to an uncompensated Commission always commanding the services of substantial citizens. The Commission has always maintained an efficient and thoroughly competent dredging organization and all of the Port's dredging operations are carried out in a thorough businesslike manner just as would be expected from any well established business organization.

The magnitude of the Port's dredging project of some ten or twelve million yards a year has made it possible to develop the very finest and highest type of operating personnel. Very comprehensive dredging records and cost data are kept and considerable sums of money are expended yearly in making tests, carrying on experiments and otherwise trying to improve dredging methods and cut down operating costs. It may be taken for granted, therefore, that the data of The Port of Portland on hydraulic pipe line dredge work is based on the experience of one of the best dredging organizations in the United States and it is

TABLE F

Power Consumption Per Cu. Yd. on Varying Lengths of Pipe Line

DATE 1925	CU. YDS. DREDGED	NET TERM LIFT FT.	PIPE LINE LENGTH FT.	INPUT TO MAIN PUMP KW.-HR.	PUMPING HRS.	INPUT TO BALANCER SET	OPERATING DAYS	TOTAL KW.-HRS.*	CU. YD. PER KW.-HR.	KW.-HRS. PER CU. YD.	PERCENTAGE OF ALL AUX. POWER TO TOTAL POWER	MATERIAL
September	413,230	29.1	6273	.....	433	.....	25	809,381	0.51	1.96	...	Sand
October	855,540	29.7	4967	.....	495	.....	26	1,081,090	0.79	1.26	...	Sand
November	426,075	31.0	5619	.....	488	.....	24	1,034,790	0.41	2.43	...	Sand
December	448,820	28.6	4887	.....	539	.....	26	895,910	0.50	2.00	...	Sand
Sub-total	2,143,665							3,821,171				
1926												
January	615,990	28.9	4564	810,100	546	32,945	26	874,920	0.70	1.42	7.41	Sand
February	467,800	25.1	6601	914,100	448	36,123	24	961,480	0.49	2.06	4.93	Sand
March	504,350	29.3	5988	1,070,600	573	41,789	27	1,131,860	0.45	2.24	5.41	Sand
April	337,580	28.5	7085	1,030,500	554	37,255	26	1,095,540	0.31	3.24	5.94	Sand
May	394,260	24.5	6288	928,050	503	39,290	25	975,350	0.40	2.47	4.85	Sand
June	152,500	27.6	3904	249,982	150	12,782	8	262,990	0.58	1.72	4.95	Sand
July	755,320	29.9	3923	916,192	510	64,744	26	993,150	0.76	1.31	7.75	Sand
August	1,027,250	31.8	2601	952,486	522	59,417	27	1,012,060	1.02	0.99	5.89	Sand
September	548,440	31.6	4229	881,854	499	62,845	25	946,490	0.58	1.73	6.83	Sand
October	659,990	30.5	3585	939,897	528	59,688	26	1,000,060	0.66	1.52	6.02	Sand
November†	364,836	28.0	4114	1,013,226	528	60,000	24	1,077,900	0.41	2.41	6.00	Sand
Sub-total	5,828,316							10,331,800				
TOTAL	7,971,981	(0.76 cu. yd. per kw.-hr.)						14,152,971	(1.757 kw.-hr. per cu. yd.)			

† Estimated month.
*Includes main pump, balancer set, and service motors. Average pipe line about 5,500 ft.—16 ft. lift. Power for the several service motors is taken off the three wire system at 250 volts and hence this power makes up for the discrepancy between the balancer set plus the main pump motor and the total power generated.

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submitted that this data should be of some practical value.

Table D shows costs of operation of Portland's dredges under logical groupings in totals and percentages with a separate total for the cost of operating electric booster pumps with the steam dredges; also the number of operating days, output, length of pipe line and power rating. Table E shows the same costs apportioned on an "operating day" and "cubic yard" basis for each group.

A study of these tables shows that the operating costs of a dredge are about two-thirds, while the maintenance costs are one-third of the total. Also that this relation holds true for all four dredges shown irrespective of variation in power or types of dredges.

Dredges at work in the harbor, Portland, Ore.

The superiority of the dredge CLACKAMAS while due largely to the economy of the Diesel engines, is contributed to also by its excess power, extreme flexibility, due to application of electrical power, efficient dredge pump, and ability to get in more uninterrupted pumping time. By employing this dredge on the long pipe line work which it handles without requiring the use of electric booster pumps, such as are used with the lower powered dredges, it effects a large yearly saving to the Port though this long pipe line work cuts down the output of the dredge over what it would have been if the pipe line had been shorter.

Our experience with the dredge CLACKAMAS, where we have an adjustable speed and variable horsepower pump motor, indicates that there is a limiting economic pump power required for each dredging condition determined by both the length of pipe line and the character of material dredged. This is constantly being proven by applying different powers to the dredge pump and measuring the resulting pipe line velocities and the yardage moved.

We have noted conditions where it required an increase of 350 hp. to be applied to the dredge pump to get an increase of 5 r.p.m. with no resulting benefits. In this case the pressure and vacuum hardly changed and no greater yardage was dredged.

On short pipe lines in sand we have found that with but three out of the four main engines operating we get all the power we need to secure maximum yardage.

In the same location with the same length of pipe line, but pumping heavy pea gravel, we find that we need the power of all four engines. The pipe line pressure goes up and the output goes down, due to the class of material being dredged.

By experience the operators of the CLACKAMAS pick out the proper and most economical dredging power to meet each set of operating conditions, which we find to vary for the various jobs the dredge is called upon to do.

This extreme flexibility is most readily obtained by electric drive, and we feel it justifies an additional first cost in large high powered dredges.

The overall efficiency of the Diesel-electric dredge has been found to be high, due to its ability to exchange power automatically between the main pump unit and the cutting units as well as the other auxiliary motor driven machinery.

The average electrical load used for all purposes other than driving the main dredging pump did not exceed 7 per cent for the CLACKAMAS during the last fiscal year, although there were peak loads requiring as much as 25 per cent of the total.

We have experienced no operating or mechanical difficulties with the vessel, in fact this dredge gives us no more trouble in this respect than our steam dredges. A great deal of credit for this excellent record for smooth operation is due to James Healy, the Port's Master Mechanic, and Clyde Teeling, Chief Engineer of CLACKAMAS, who are both very capable men thoroughly grounded in their line of work.

All the electrical equipment was furnished by the Westinghouse Electric & Manufacturing Co. and the application of direct current to dredging purposes has been most satisfactory. The operation of the electrical equipment has been simple and economical. We have had no major repairs or replacements to make and practically all of the maintenance work has been accomplished by the regular operating crew.

The four main Diesel engines totaling 3400 b.hp. were built by the McIntosh & Seymour Corp. of Auburn, N. Y. and have proven to be most satisfactory.

No major repairs have been necessary on these engines except for the replacement

Part of Clackamas' 30 in. shore pipe line

Discharge of 30 in. shore pipe line

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of one crank shaft whcih had a hidden flaw in the forging. We have experienced no trouble in operating all four engines continuously night and day throughout the week under full load conditions. Sunday is used as a dredge repair day at wh'ch time the engine maintenance is also taken care of. This work has consisted chiefly of the usual changing of exhaust, fuel and intake valves, taking up the slight bearing wear and cleaning of lubricating systems. It has been found advisable in order to remove carbon and properly to maintain free piston rings, to remove pistons about every 6 months. By doing this, cylinder wear is reduced and possible scored liners or pistons, by the accumulation of carbon behind rings and on piston tops, are eliminated. Cylinder wear averages about 1½ thousandths per month.

The main Diesel engines are successfully burning what is known in this district as ordinary boiler fuel oil. The gravity of this fuel naturally varies, but is what is regularly furnished by the Standard Oil Co. of California as their commercial fuel oil for burning under steam boilers.

We have also burned what is known as commercial Diesel oil, gravity about 24 deg. Baume, with excellent results. We ran an exhaustive test of several months duration to determine the advantages of each fuel.

TABLE G

Bearing Wear on Four Main Diesels of Clackamas for Fiscal Year 1926

ENGINE	No. 1	No. 2	No. 3	No. 4
Main bearing ...	0.006	0.008	0.005	0.005
Crank pin	0.003	0.0025	0.001	0.001
Piston pin	0.012	0.008	0.002	0.002
AIR COMPRESSOR				
Crank pin	0.006	0.010	0.006	0.006
Piston pin	0.002	0.003	0.001	0.002

During this period the dredge got in an actual total of 5932 hrs. pumping. Engines Nos. 1 and 2 have six cylinders with oil cooled trunk type pistons 22 in. diameter, developing 900 b.hp. each at 150 r.p.m.

Engines No. 3 and 4 have eight cylinders with uncooled trunk type pistons 17 in. diameter developing 800 b.hp. each at 200 r.p.m.

The air injection compressors operate continuously with the engines and with occasional regrinding of valves perform in a most satisfactory manner.

The exhaust valves on the main engines are changed every 3 months and the intake valves every 6 months. This condition held true whether we were burning either boiler fuel oil or Diesel oil.

The wear on the main bearings and crank pin bearings has been very light as Table G shows. The wear on the piston pin bearings has been more severe and it is now estimated that after 2 years' operation these bearings will have to be rebabbitted due more to the cracking of the babbitt than to the actual wear.

We have experienced no trouble whatever with Diesel engine misalignment or engine vibration.

The use of oil cooled pistons on a dredge, in my opinion, tends to complicate the operation and we find the uncooled or dry piston type of Diesel engine the more satisfactory and cheaper to operate.

The total power rating of the four main Diesel engine generating units on the CLACKAMAS is 3500 b.hp. and these generate 2300 kw. at 500 volts d.c.

The engines have been lubricated with Calol Diesel oil supplied by the Standard Oil Company of California. The kw. output per gallon of cylinder oil has averaged 2617 kw. for the year.

Both Sharples and DeLaval mechanical separators have been used with success to clean the fuel oil before burning and purify the used lubricating oil.

Atlas-Imperial Makes New Small Diesel

The 4-Cylinder 40 hp. Unit Is One of the Smallest Cold Starting Engines Now on the American Market

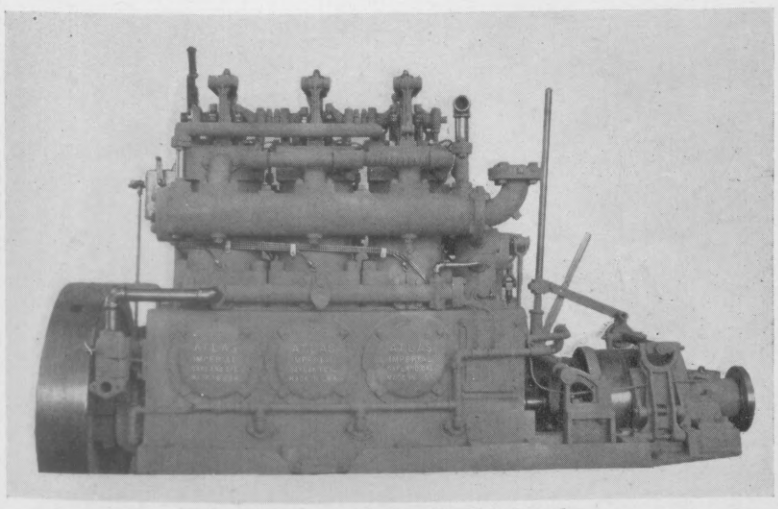
ATLAS-IMPERIAL Engine Company have, after about 2 years preliminary work, recently completed one of the smallest 4-cycle high compression cold starting engine on the American market. Rated at 10 hp. per cylinder, it is now in production in three and four cylinder combinations, developing 30 and 40 hp. respectively at 500 r.p.m.

The new engine, suitable for all sorts of small domestic ship types, is the result of research work into the underlying principles of combustion along solid injection lines. Various cylinder sizes and stroke-bore ratios were manufactured and tested before the present engine was finally put into production. As now manufactured, it has a bore of 6 in. and a stroke of 8½ in. and is rated at 30 hp. in the 3-cylinder size and 40 hp. in the 4-cylinder size.

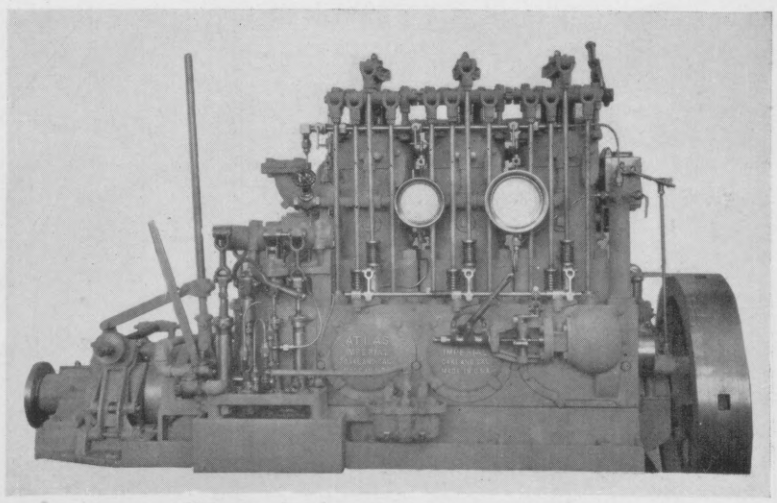
The first engines to come through the regular commercial test showed what is regarded as exceptional performance and economy. Of particular interest was the absence of vibration and the surplus of power above the ratings. No serious vibration was noted at speeds as high as 600 r.p.m. and combustion was complete.

Following closely the standard adopted by the manufacturers, the new machine shows little variation from other models built by the Atlas-Imperial Engine Company. Yet the conservative perfection of an engine capable of cold starting without the use of artificial means is a distinct contribution to the art in so far as small cylinder sizes and high rotative speeds are concerned. When the Atlas-Imperial Company set out to develop this small engine, in response to a popular demand for small powers that would equal, or at least approximate the economy of their larger models, it was with the full knowledge that they had a difficult task before them.

A survey of the existing markets and requirements revealed four fundamental requirements that were not easy of accomplishment. First light weight; second moderately high rated speeds; third Diesel engine economy, and fourth low cost had to be obtained. The first requirement was easily met. The second presented probably the greatest difficulty on account of the short time allowed for injection, atomization and combustion of the fuel and this requirement consumed most of the experimental and research work. The third requirement followed easily after the accomplishment of the second. That the fourth has been met is evidenced by the price.



10 hp. per cylinder is developed



New engine has compact arrangement

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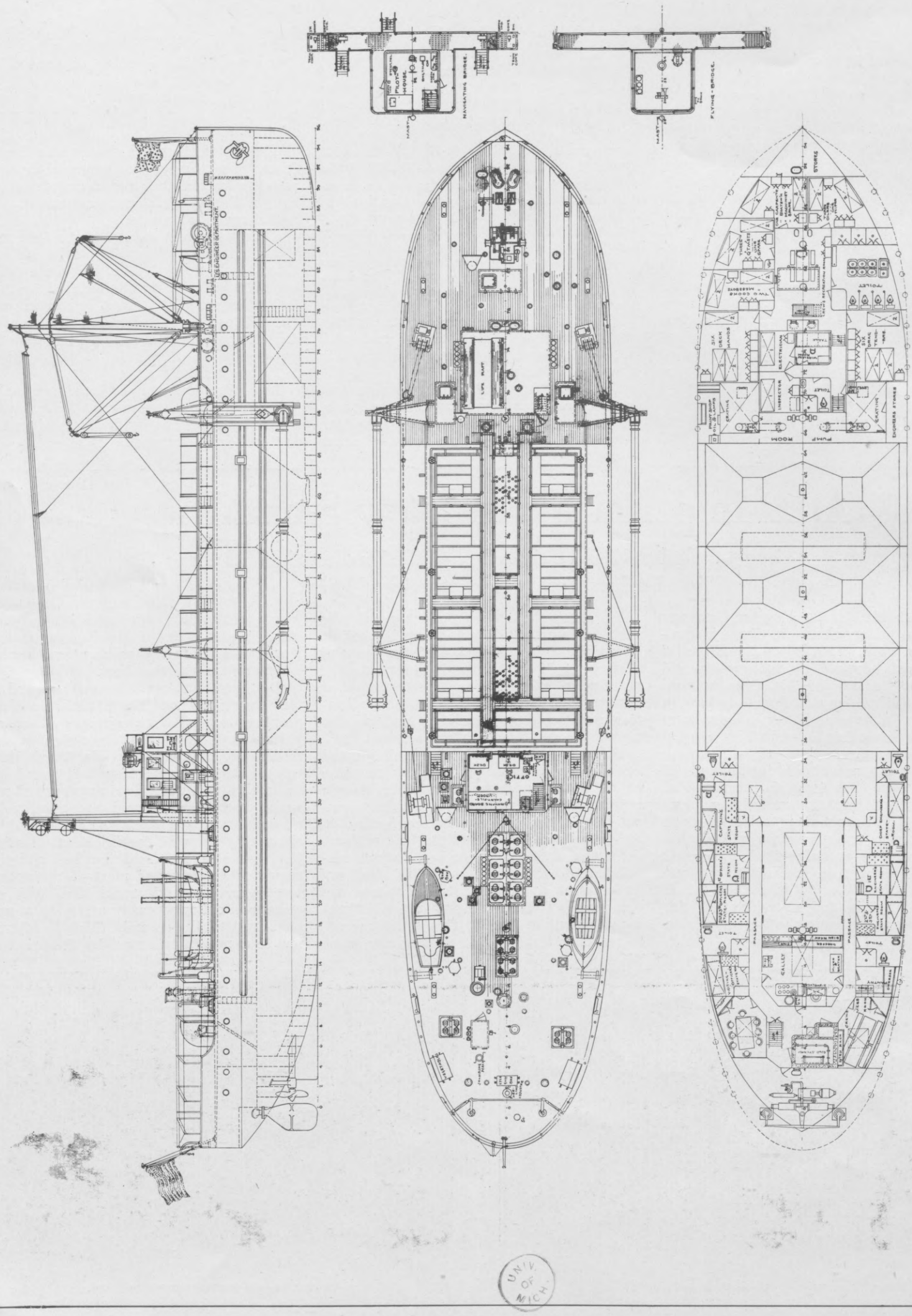

General arrangement of the 200 ft. Diesel dredge Willet's Point, built at Kearny, N. J., well shows the many novel points in her design

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Sea Going Hopper Dredge "Willets Point"

Novel Features Incorporated in New Vessel's Design and Construction Permit of Wide Range of Applicability in Dredge Work

By Northrop R. Fletcher*

UNITED States Engineer Department sea-going hopper dredge WILLETS POINT is not only the latest addition to the fleet of ships of this type now operated by the Government, but in her design an attempt has been made to build a dredge suitable to work where other dredges cannot be used with advantage. Thus, while in her general plan of operations WILLETS POINT is similar to older dredges, there are many new and novel features incorporated in design, in machinery layout and in general arrangement.

Every dredging project presents different problems. A plant designed with certain operating conditions in mind is not always economical on other work. In some cases large dredges draw too much water or cannot be maneuvered in existing channels. For such work it has been the policy to use a small light draft boat until the channel is safe for a larger one. Where the distance to the disposal area is great, the small and slow dredges will spend so much time going to the dump that the cost of actual work done will be high. With such problems in consideration, WILLETS POINT has been built with fairly small overall dimensions, a moderate speed, shallow draft, and moderately large hopper capacity. All this has been made possible by the use of high speed Diesel engines for propulsion, dredging and auxiliary power.

In design, WILLETS POINT incorporates the experience of the Engineer Department in the construction and operation of innumerable dredges of different types and designs, and the features of existing boats were studied by the Marine Design Division of the Chief of Engineers' Office in Washington. This work was done under the direction of Major W. D. Styer, Corps of Engineers, U. S. Army. Major Styer was at that time in charge of the Marine Design Division. Since that time he has been transferred to the First New York District Engineer Office, where he has been able to give personal attention to the construction of the dredge, which was built by The Federal Sb. Co., Kearny, N. J.

*Inspector U. S. Engineer Office, 1st New York District.

Characteristics of Willets Point

Length overall	200 ft. 2¼ in.
Length b.p.	193 ft. 0 in.
Breadth, over fenders (drags removed)	42 ft. 6 in.
Breadth, molded	41 ft. 0 in.
Depth, molded to main deck	19 ft. 6 in.
Draft, mean, salt water loaded	16 ft. 5 in.
Draft, mean, light (hoppers dry)	7 ft. 11 in.
Draft, mean, light (hopper doors open)	9 ft. 1 in.
Displacement, loaded, salt water	2966 tons
Displacement, light	1300 tons
Gross tonnage	1164.85 tons
Hopper capacity (three hoppers)	1170 cu. yds.
Speed, loaded, estimated	10 m.p.h.
Speed, light, estimated	10.5 m.p.h.
Metacentric height, light (hoppers dry)	20.28 ft.
Metacentric height, light (hopper doors open)	10.22 ft.
Metacentric height, loaded	4.3 ft.

WILLETS POINT has no shear, very little freeboard, and no superstructure other than the pilot house and bridge aft of the hopper space. This lack of superstructure is made up for by a forest of exhaust pipes, cowl ventilators, air suction pipes, stacks, davits and hydraulic cylinders. The mainmast, forward, is short. The mast abaft the pilot house is more in the nature of a small signal staff.

Unlike the government owned Diesel-electric dredges of the MACKENZIE class, WILLETS POINT retains the side drags of the older steam dredges. These drags or suctions consist of 15 in. pipes attached one to each side of the hull by ball and socket joint fittings. At the lower or after ends of these pipes are the drag heads which serve to agitate and strain the mud or sand to be removed. The drag heads, which follow somewhat the design known as New York or Ambrose Channel type, consist of flat, heavy, hollow castings, the shape of a large hand. The bottoms consist of renewable gratings with holes about 5 in. square.

The gratings are cast steel treated by the Stroh steel hardening process to reduce the excessive wear usually suffered by these parts. The size of the holes in the gratings is such that they will not pass any rocks or solids that will not easily pass the volute clearances of the dredge pumps without doing any damage.

In dredging, this drag is lowered to the bottom of the channel and the dredge moves at a speed of about 2 m.p.h. in order to agitate the mud or sand. This material, with a large amount of water to make it

Hopper dredge Willet's Point, propelled by two Diesels, has three hoppers of 1170 cu. yds. total capacity

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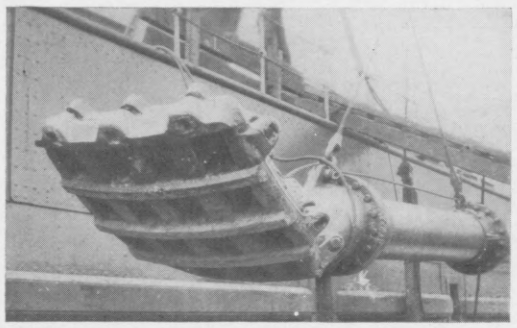
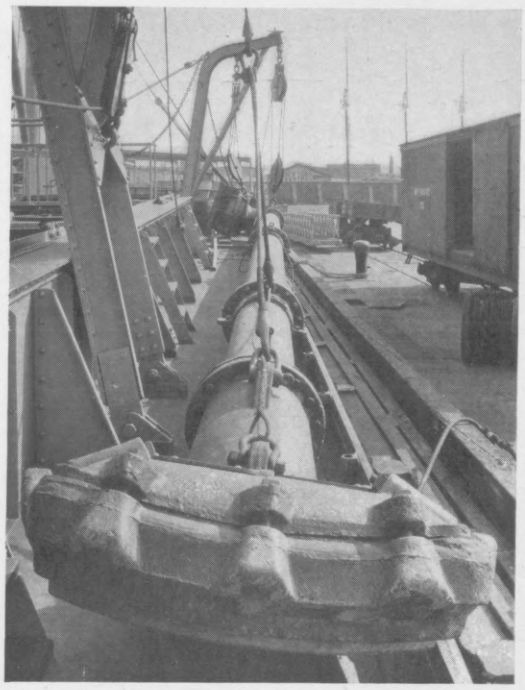
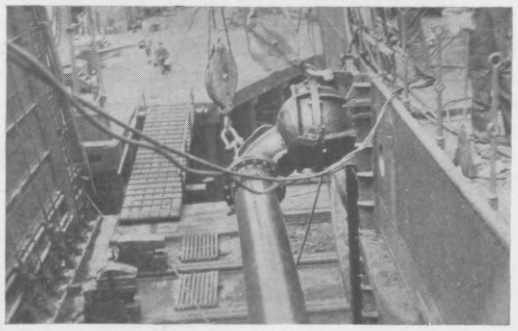
fluid, is drawn up through the drag head and pipe by the dredge pumps and is discharged through pipes running longitudinally over the hoppers or bins. For each of the two pumps attached to the dredge arm there is a separate discharge pipe. On each of the discharge pipes over the hoppers a discharge nozzle is fitted for each of the three hoppers. These nozzles are of cast steel of rectangular cross section with curved flanges riveted to the discharge pipes. The discharge end of the



Starboard drag head



Starboard drag line



Ball and socket drag attachment

nozzle is closed with a curved, swinging gate to control the amount of material admitted to the hopper and thus to trim the ship. This form of discharge pipe is somewhat different from the open trough ordinarily used. The closed pipe, however, is not new—it has been used very successfully on a few dredges. Although the closed pipe is liable to become choked with trash, it overcomes some of the objections of the open trough. Unless the trough has a decided slope, the velocity of the material is liable to be lost, the trough will become choked with heavy sand and gravel or clay and it will be difficult to fill the hoppers at the end of the trough. In the closed pipe the velocity can be maintained by the pressure of the pump.

The heavier material settles to the bottom of the hoppers, the water rises to the top and drains overboard through overflow troughs. When the hoppers are filled with solid material the dredge runs out to sea or to some disposal area. Doors in the bottom of the hoppers are opened and the material drops out.

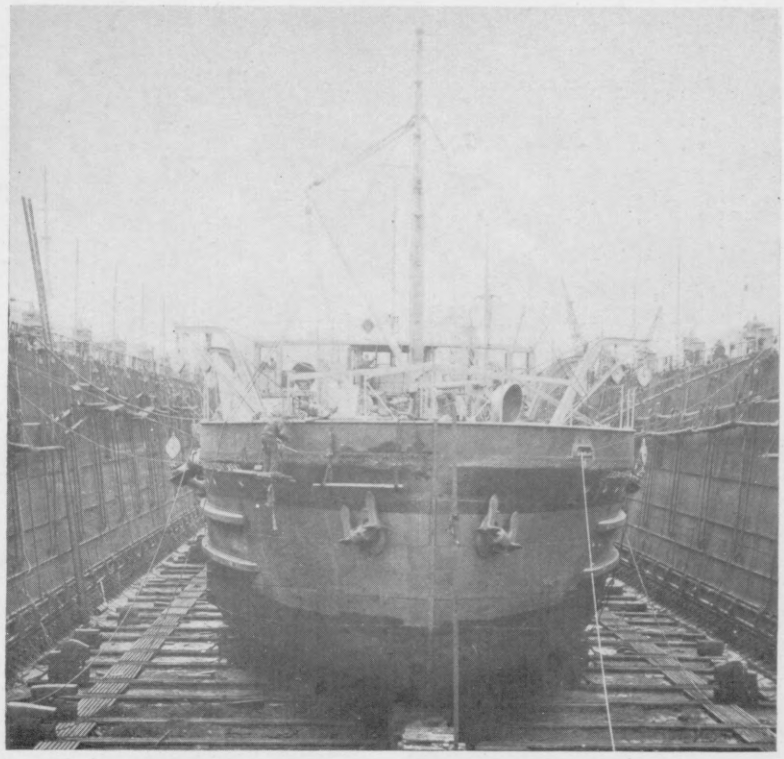
WILLETS POINT has been constructed with a view to her being able to pass to the Great Lakes via the New York State Barge Canal and the overall dimensions were fixed accordingly. The governing lock dimensions of these canals are:

Usable length	300 ft. 0 in.
Usable width	44 ft. 6 in.
Depth of water	10 ft. 0 in.
Distance from w.l. to bridge clearance	15 ft. 6 in.

Referring again to the dimensions it will be noted that a clearance of 1 ft. on each side over the fenders has been allowed, because the drag pipes which extend beyond the fenders can be removed.

It has been necessary to give careful consideration to weights and distribution of weight so that it will be possible to trim the dredge to an even keel with a draft of approximately 9 ft. 6 in. with full stores, one-half fuel and one-half potable water aboard. In order to do this it will be necessary to use one or two of the hoppers as trimming tanks. With the draft fixed thus by the governing depth, the height of any part of the dredge above the extreme bottom of the keel has been limited to 23 ft. 6 in., so that 1 ft. 6 in. is allowed for bridge clearance. All houses, ventilators, exhausts and other equipment extending above this clearance line have been made portable and capable of being dismantled and stowed below the clearance line.

The 40 ft. mainmast forward is hinged at the deck with a gooseneck and pin and so arranged that it can be lowered to the deck at an angle of about 20 deg. on the starboard side of the centerline. The short signal staff aft of the pilot house is so arranged that it can be easily dismantled. The only deck house extending above this clearance line is the office or chart room on the main deck aft of the hopper space, and the pilot house and bridge above. The office is built of steel and cut on all sides to about 3 ft. 0 in. above the deck. At this line, angle bars are riveted to the upper and lower halves and bolted together. The paneling that forms the sheathing inside the house is so arranged that it can be removed when the office is dismantled. The



Bow view of ship shows bluff lines

Stern view shows twin balanced rudders

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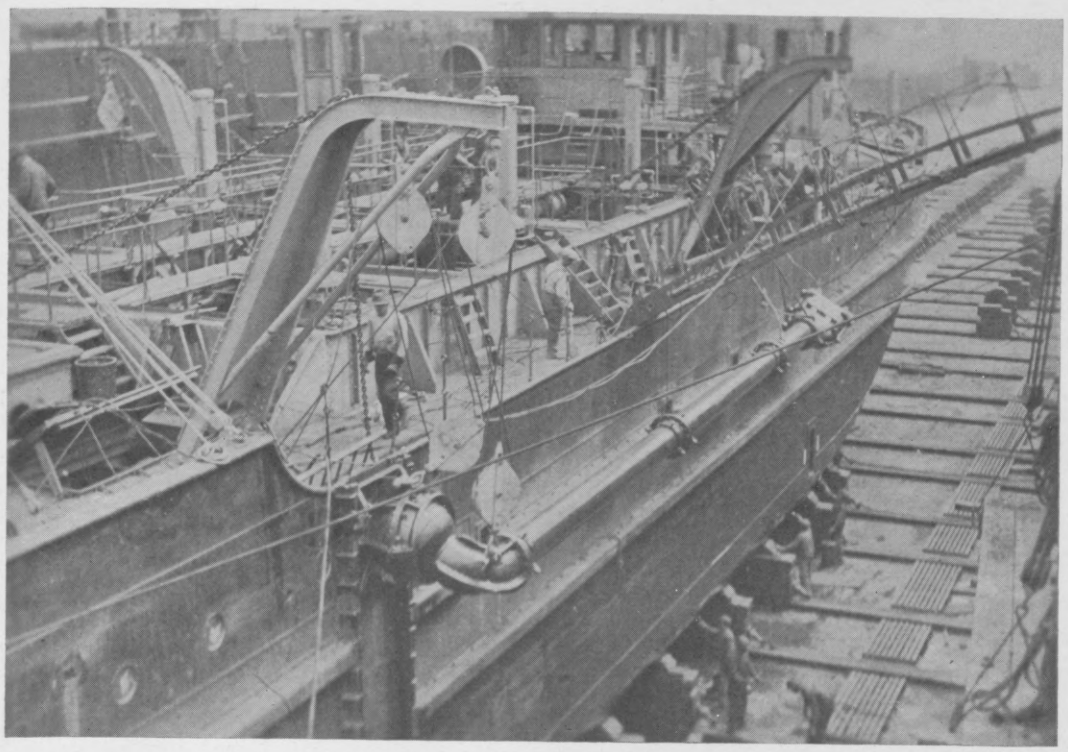
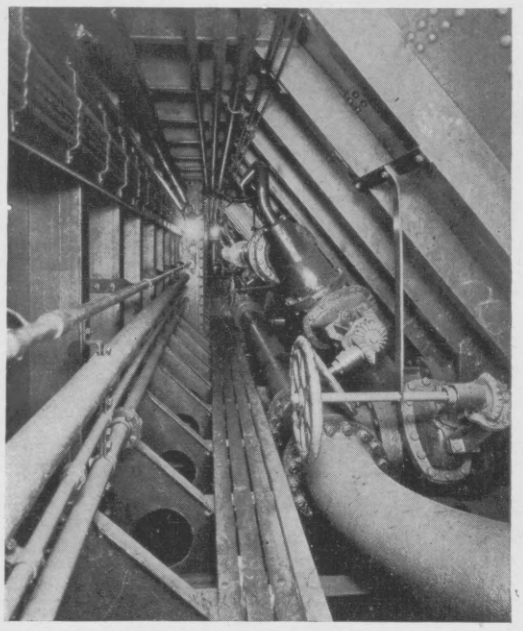


Port side view showing drag pipe and hull attachment

pilot house is of wood and built in carefully fitted and matched sections so that it can be easily dismantled and reassembled. The bridge and flying bridge are of steel, also built in sections and bolted together.

All exhaust pipes and air suction lines have flanged couplings at the clearance line. The life boat davits are of the Stewart type and so arranged that they can be swung inboard to lie flat on the deck. The operating screw and bracket are built to stand below the clearance line. The steering stand and the engine order telegraphs are so arranged that these instruments can be mounted on the main deck when the bridge is removed. The steering engine is of the hydro-electric type with an electric telemotor. The engine order telegraphs are of the direct current, magnetic type. The two instruments on the wings of the bridge are mechanically connected by chains and wires to a master transmitter in the pilot house. The reply from the engine room is electrical to all three deck instruments. In order to mount these instruments on the main deck duplicate junction boxes have been provided as well as a duplicate set of mechanical wires with pulleys and chains for synchronizing the three instruments. These connections are installed below the main deck and covered with flush deck plates. Special short stands had to be provided for the telegraph transmitters in order that these instruments would be below the clearance line when installed on the main deck.

The entire hull is of steel and has been built in accordance with the current rules of the American Bureau of Shipping. In designing the hull, the transverse system of framing has been used but special attention has been paid to the longitudinal strength. All keelsons, longitudinals, and stringers are of extra heavy design, well placed and overlapping where cut or not in line. In the engine room, the side keelsons and longitudinals have been used to form part of the foundations for the propelling engines. Under the hopper space the side keelsons and longitudinals are tied in with the framing around the hopper doors. The side keelsons have been carried well forward and aft so that a very rigid structure has been the result. This extraordinary longitudinal strength is necessary on account of stresses set up in ordinary service. In filling or dumping the dredge it is practically impossible to control the distribution of the load. This is particularly true of dumping. One pocket may suddenly dump clean when the door is open while the mud in another pocket will "hang up." The ship may be down by the head and listing 20 deg. before all the mud is disposed of, and she can be brought back to normal. In 1924, while dumping in a heavy sea, the dredge WM. T. ROSSELL registered a list of about 37 deg. to port and 28 deg. to starboard on her clinometer. One some of



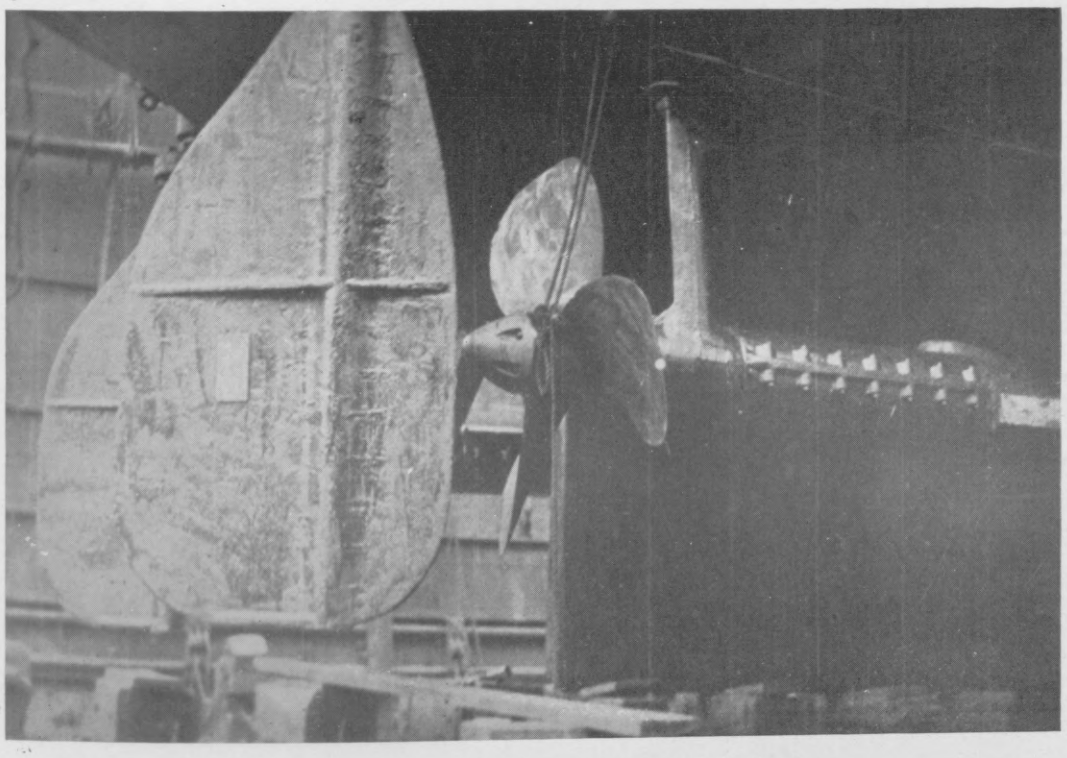
Bilge under hopper spaces

the older dredges, trouble has been experienced from hogging because the extra longitudinal strength required by the hull was not recognized in the design.

In order to facilitate steering at low speeds when the boat is dredging two balanced rudders are used each directly behind a screw. These rudders are very much oversize, having an effective area of about 42 sq. ft. each. The use of these rudders together with twin screws should make the boat very easy to maneuver. Such control is very essential in dredging. To work effectively the dredge must be kept accurately on the ranges and course where the material is to be removed. The pull of the drags on either side is seldom equal. This pull together with possible cross currents and winds prevent a steady course.

In order to use a standard steering gear, tillers for the two rudders are connected by a link to a tiller on a dummy stock connected to the rams of the hydraulic gear. This dummy stock also drives the transmitter for a Hyde, helm angle indicator.

[*To be continued*]



Twin cast rudders and special propeller shaft bearings

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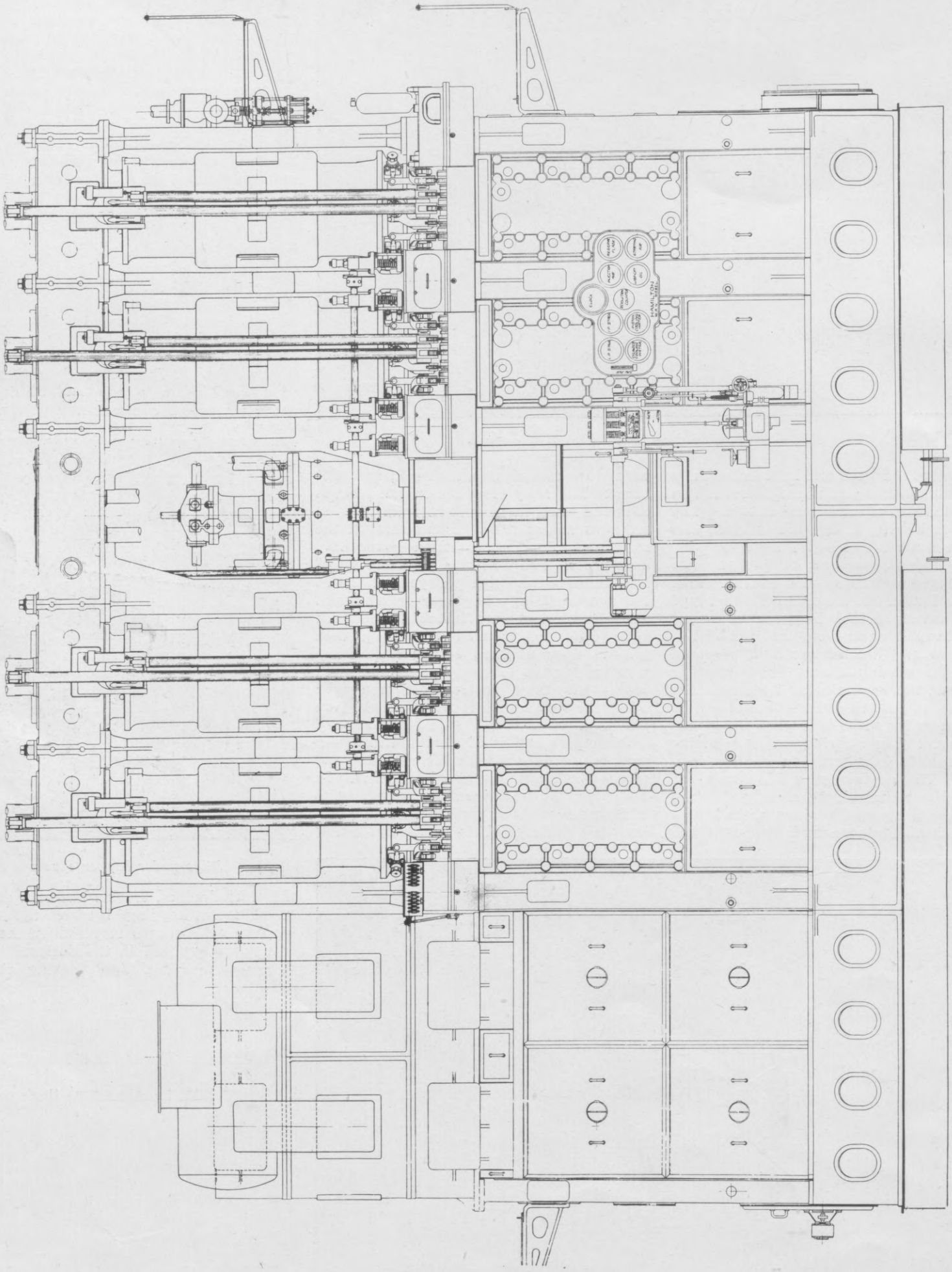

Outline drawing of the 3300 hp. Hamilton-M.A.N. 4-cylinder double-acting 2-cycle marine Diesel built especially for the U. S. Shipping Board for installation in a converted freighter

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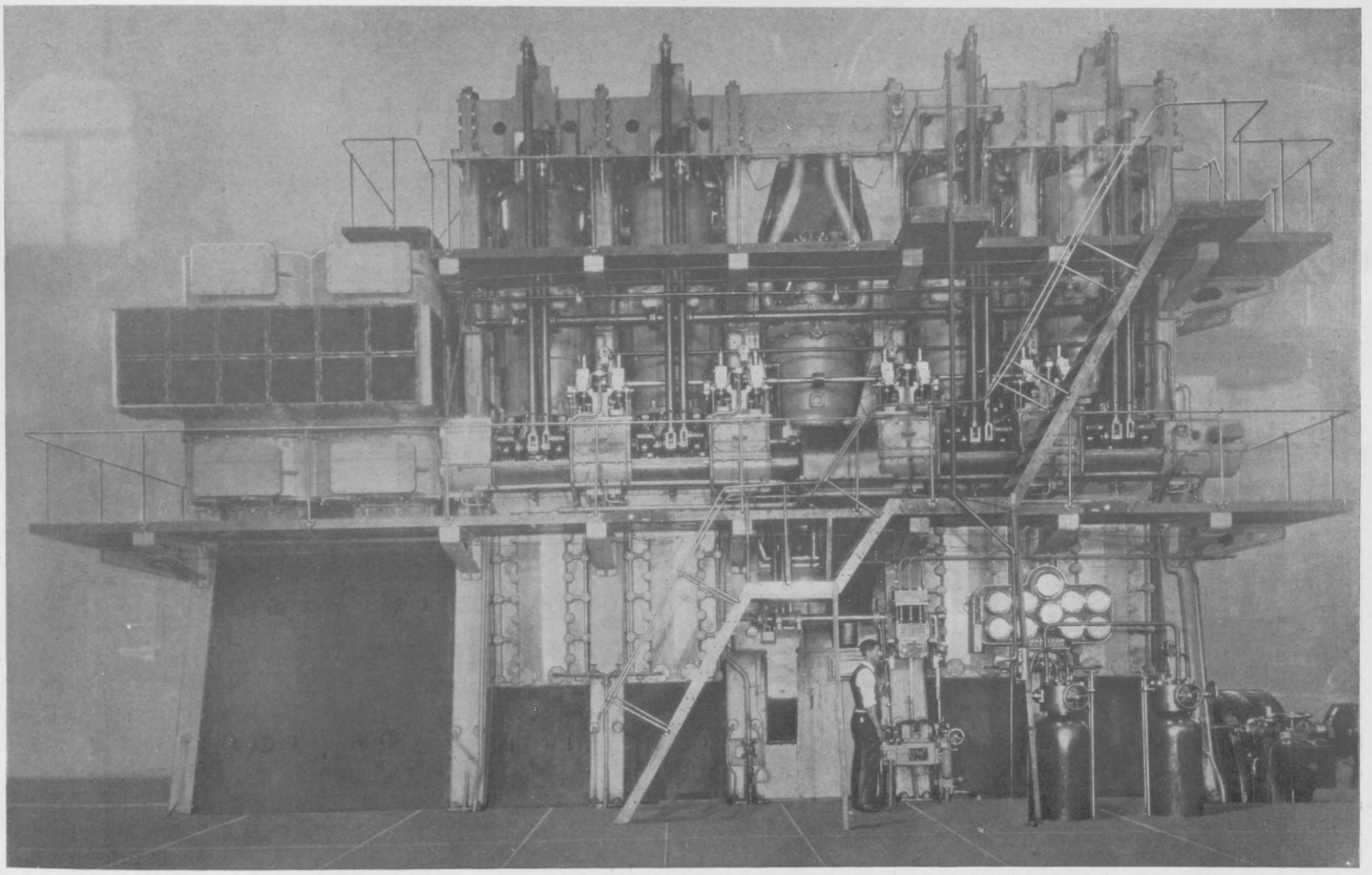
Hamilton M.A.N. Double-Acting Diesel

New Two-Cycle Unit, Developing 3300 b.hp. in Four Cylinders, Has Highest Cylinder Output of Any Diesel in U. S.

IN the Hamilton, Ohio, shops of the Hooven, Owens, Rentschler Company, a 4-cylinder double-acting 2-cycle engine of 3300 b.hp. has recently been put through its paces. It is destined for the 9600-ton Shipping Board cargo ship SEMINOLE, which when completed, will enjoy the distinction of being powered with Diesels of the largest cylinder output thus far commissioned in the United States.

Rated to deliver 3300 b.hp. at 95 r.p.m., this 4-cylinder engine still seems conservatively dimensioned, in view of its being credited with 4500 hp. at about 120 r.p.m. Keen interest centers in the particulars of a design which makes possible the development of 825-1125 hp. per crank.

The secret appears to lie in the double-acting 2-cycle principle forming the basis of the Hooven, Owens, Rentschler design. Licensed by the famous M.A.N. Works of Augsburg, Germany, this firm has recently concluded the task of adapting the new engine principle to American operating conditions, and has gained the distinction of being the first company to complete a M.A.N. engine outside Germany. The production of 1125 b.hp. in a single cylinder is a feat which perhaps would be difficult to duplicate by any method other than the double-acting principle coupled with the loop-scavenging method—the fruit of intensive research at the works of the historic Diesel engine builders. Owing to the utmost utilization of the framing and moving parts of the engine which have thus been made possible, the development of record-breaking cylinder outputs does not apparently call for cylinder dimensions of unmanageably large extent—witness the fact that the bore and stroke dimensions are only 27½ in. x 74¼ in. and the speed of 95 r.p.m. is one entirely conventional. The mean indicated pressure is less than 90 lb.



The Hamilton-M.A.N. double-acting 2-cycle Diesel developing 3300 b.hp. in four cylinders has just completed a successful 30 day test

Characteristics of Hamilton-M.A.N. Double-acting Diesel

Type	double-acting 2-cycle
Total power	3300 b.hp.
Speed	95 r.p.m.
Number of cylinders	4
Cylinder diameter	27½ in.
Piston stroke	47½ in.
Weight (total)	850,000 lb.
Length overall	40 ft. 0 in.
With overall	15 ft. 0 in.
Height above shaft center	28 ft. 0 in.

Two power impulses obtained from each cylinder per revolution make this machine the equivalent of a 16-cylinder 4-cycle single-acting engine. That is the explanation for its ability to develop so large an output without resort to excessive cylinder sizes, pressures, or high piston speeds.

In addition to the four double-acting power cylinders there is a 3-stage compressor for starting and injection air, also a twin cylinder double-acting scavenging pump. The entire engine weighs only 850,000 lb. and measures 40 ft. 0 in. overall. It is 15 ft. 0 in. wide and rises to a height of 28 ft. 0 in. above the shaft center.

The engine operates on the air injection principle and has one fuel valve located in the upper cylinder head and four fuel valves located in the lower cylinder head. In addition, there are starting valves both on top and bottom, and relief valves.

The fuel valve is in the center of the head and is the only valve in the head proper. The starting valve and the relief valve are fitted horizontally in the upper part of the cylinder, and recesses for them are formed in the heat shield. Through the lower cover of course passes the piston rod, for which a water cooled stuffing box is provided in the outer cover. This stuffing box prevents a central fuel valve being used, and in place of it are found four small horizontal fuel valves, slightly offset from the cylinder diameter in order to give a good distribution of fuel without the sprays impinging upon the piston rod. A starting valve and a relief valve are fitted in the

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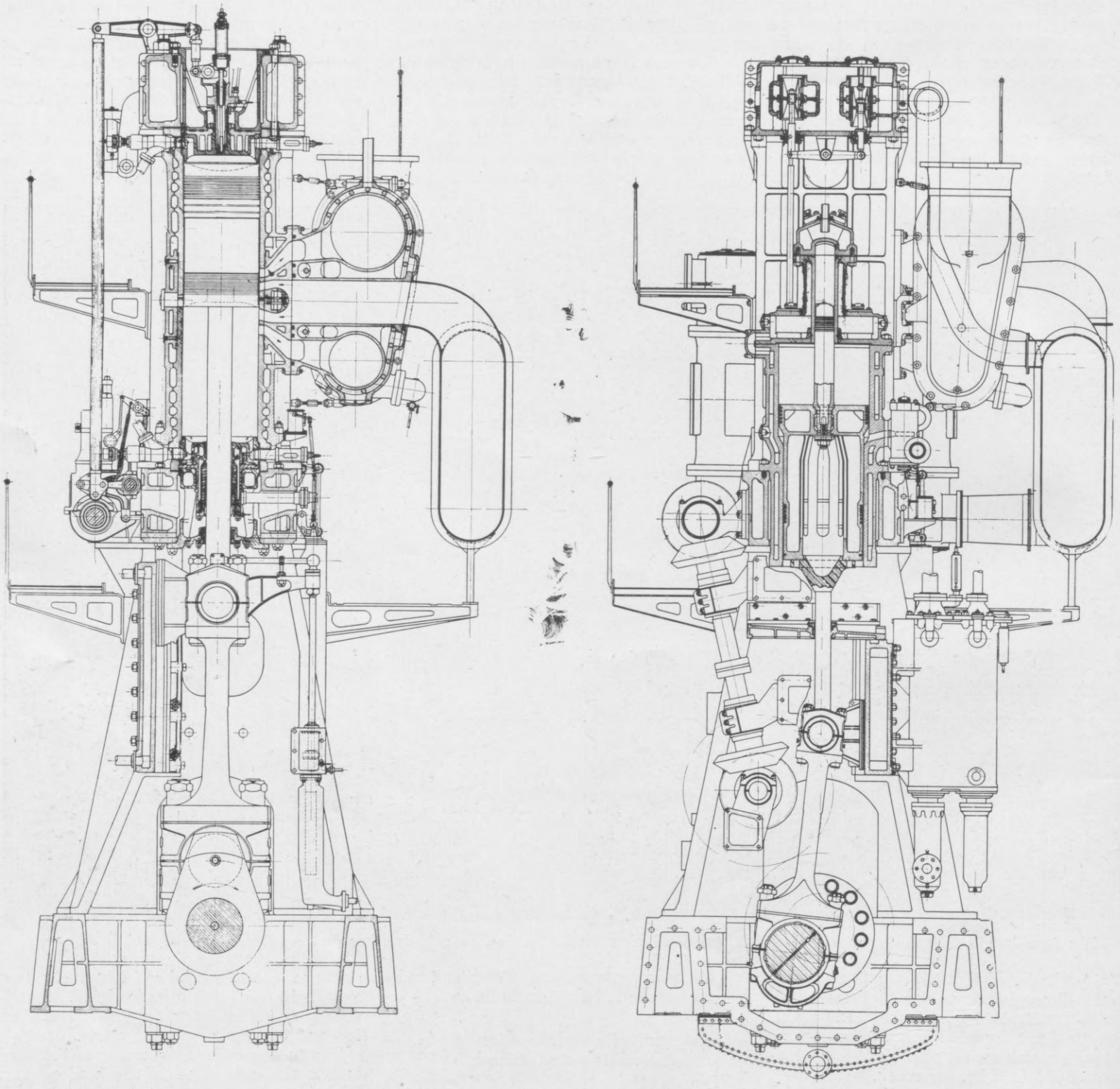
lower cylinder end in the same manner as in the upper cylinder end.

A feature of the starting valves is that they are arranged to stay shut during all periods when the pressure in the cylinder exceeds the pressure of the starting air supply. With this precaution it is deemed permissible to allow the fuel pumps to operate during the engine starting period.

The engine operates on the M.A.N. patented system of scavenging. Each liner has two sets of ports on the same side; one directly above the other. The lower ports are the scavenging ports and the air is blown in across the top of the piston and forced to the top of the cylinder; then exhausted through the exhaust ports directly above the scavenging ports. This system has been thoroughly tested and has proven exceedingly efficient not only in the preliminary investigation but in engines already in actual operation. The angles of the ports directing the air are carefully made so as to be able to bring the air current to every part of the cylinder.

The construction of the engine is made up of a bedplate with wide and deep sections. Directly on top of the bedplate are the housings, bolted to the top of the lower entablature, which is of a heavy, cast-iron section and extends the entire length of the engine. To the upper face of these entablatures are set the cylinder columns which again tie into the upper entablatures. The upper entablature is of similar construction to the lower, of a deep section, and goes the entire length fore and aft of the engine. In addition to all these joints being held by bolts, there are also four tie bolts with Milton nuts for each cylinder which extend from the bottom of the bedplate to the upper part of the upper entablatures.

The cylinders and cylinder jackets are set in between the columns, and inside of the cylinder jackets are liners made in halves—one for the upper and one for the lower. To the lower entablatures is bolted the cylinder jacket and to the upper entablatures is bolted the upper cylinder liner. The cylinder liners are so arranged that there is an opening in the center giving freedom of expansion. The cylinder jacket is held to the upper liner by a stuffing box giving it also freedom of expansion and contraction. The idea of the entire construction is to make a solid structural design in which all the tensile stress is absorbed by the tie rods. Tying the various members both athwart ship and fore and aft gives the entire engine a rigidity which



Sections through working cylinder (left) and main compressor (right) of the Hamilton-M.A.N. double-acting 2-cycle 3300 hp. Diesel

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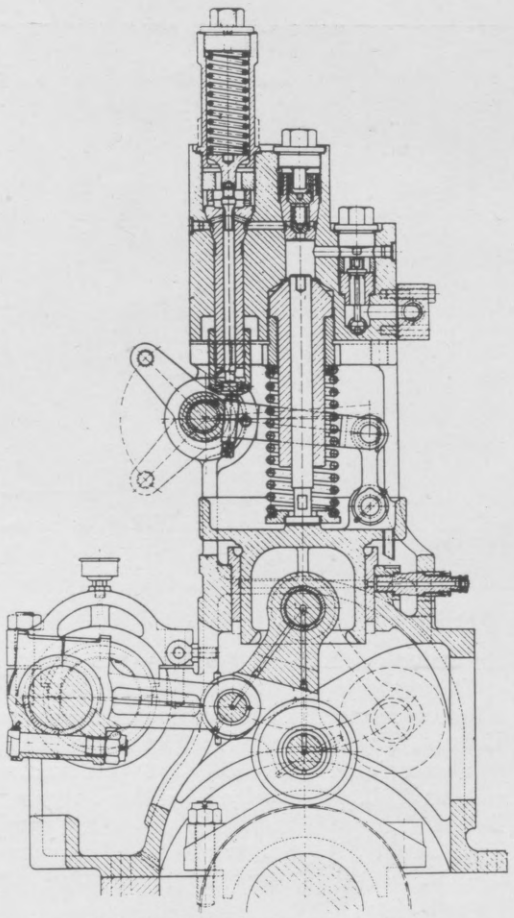
eliminates weaving or vibration and giving freedom of expansion to the liners and cylinder jackets which are subjected to the heat of combustion.

In the cylinder head is seen the evolution of the idea originated by M.A.N. a good many years ago of having a separate part for taking care of the heat stresses and an outer cover for resisting the mechanical stresses. The inner cover is generally referred to as a heat shield and is just a shallow water cooled drum. The outer cover is entirely uncooled and serves not only for holding the fuel valve, but is made deep enough to act as a member of the rigid girder formed at the top of the engine by bolting all the heads together.

The air compressor is of the conventional 3-stage type driven from the crankshaft through connecting rod and guide with crosshead. The pistons are of the step design with the high pressure on top, the low pressure in the middle and the intermediate at the lower end. The air is cooled between the stages through coolers provided with water separators so as to draw off the moisture from the air between each stage.

The scavenging pumps are of the double acting type with plate valves particularly designed for low air pressure. They are driven through crossheads from the shafts. Reed air filters ensure a supply of clean air to the pumps.

For operation of the valves there is a single camshaft extending along the entablature and driven from the crankshaft through an intermediate shaft by means of gearing. On it are arranged separate ahead and astern cams of Rowbottom make for the fuel valves and starting valves, the valves in the cylinder head being operated by push rods and those in the lower end by bell cranks. For reversing, the camshaft is moved longitudinally in order to carry the desired set of cams under the respective cam rollers.



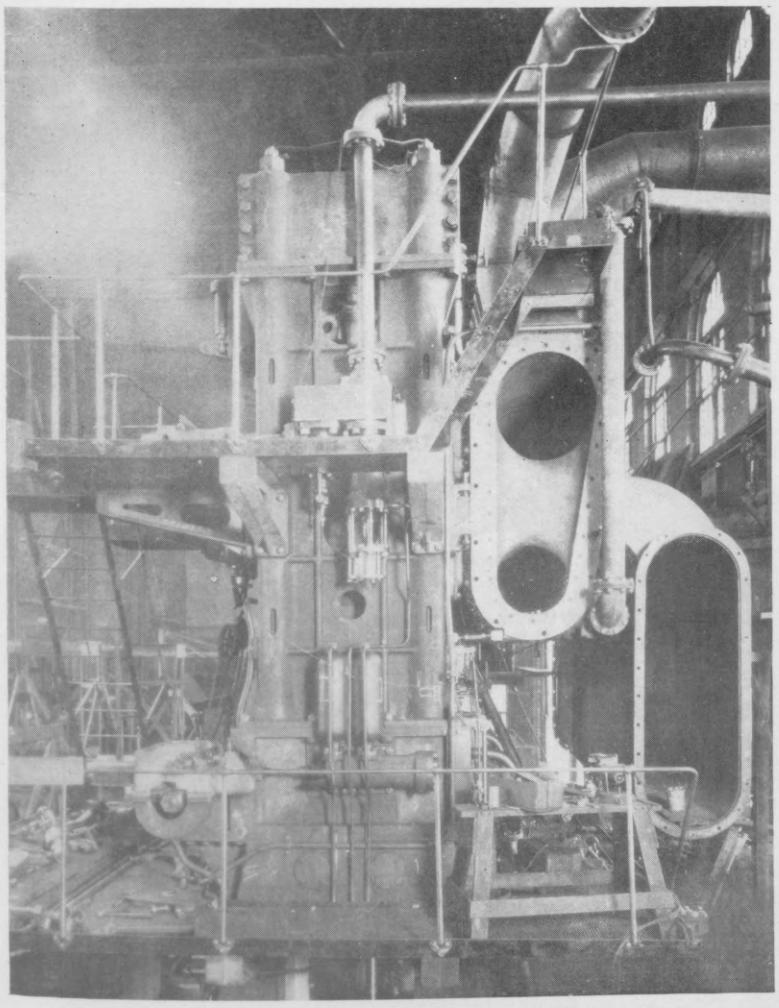
Details of fuel pump and drive

The fuel pumps are located on brackets directly above the camshaft and are driven from cams on the camshaft. This feature is novel and gives a timing to the fuel pumps which makes possible a closer regulation of the engine. There is one fuel plunger for each upper and lower cylinder.

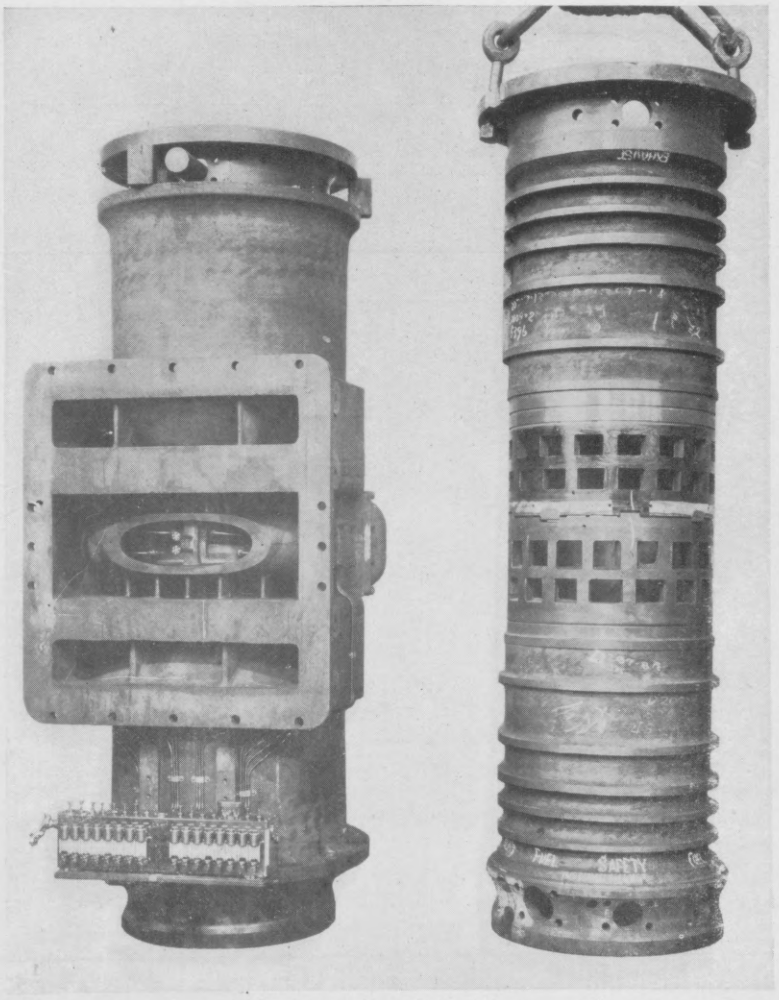
The operating gear for the engine is located on the lower platform and consists of one lever which completely operates the engine for starting, reversing and stopping. The operation is carried by means of high pressure air to the main starting valve and reversing engine. In addition, there are located on the operating platform one lever for regulating the amount of fuel and also one lever for operating the amount of air for the air compressor. The injection air pressure is controlled by handwheel.

The engine is provided with an overspeed governor of the Aspinall type. The regulation of the engine is accomplished by by-passing the discharge valves on the fuel pump. The starting valves are automatically cut out as soon as the engine gets sufficient compression for igniting the fuel. The entire engine is enclosed and subject to forced lubrication, lubricators of Manzell type being used, and a complete system of water cooling to give the proper circulation and speed of water where rapid extraction of heat is required.

The piston is cored out and the piston rod is hollow for circulation of the cooling water to the pistons. The piston rings have been supplied by the American Hammered Piston Ring Co. The inlet and outlet of the water is through telescopic piping driven from the crosshead of the engine and working through stuffing boxes into air chambers so as to absolutely seal the water from getting into contact with the lubricating oil. C. Lee Cook metallic packing has been used where necessary throughout the engine.



Showing scavenge and exhaust headers



Cylinder and cylinder liner

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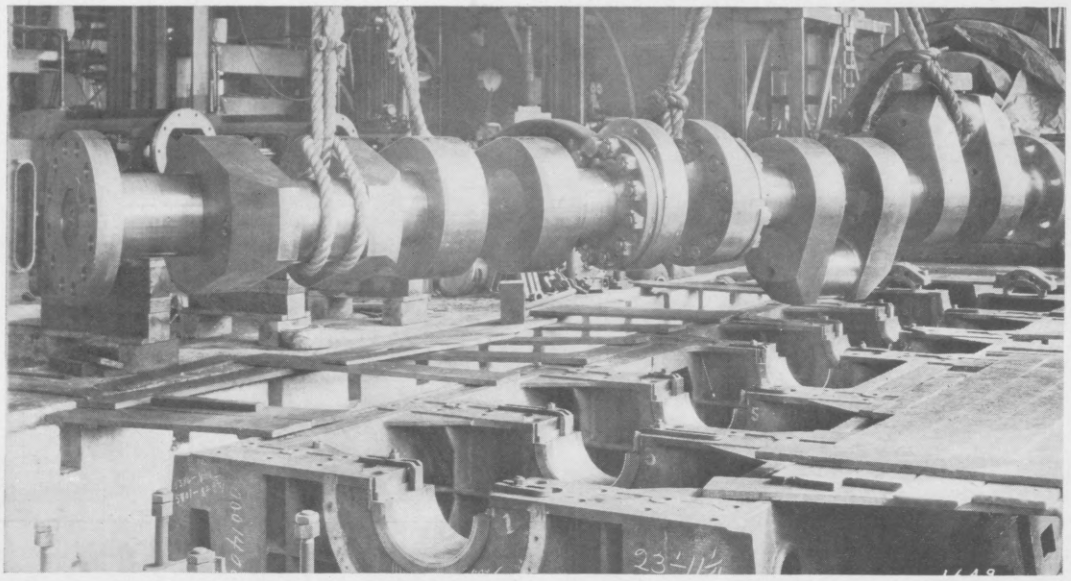
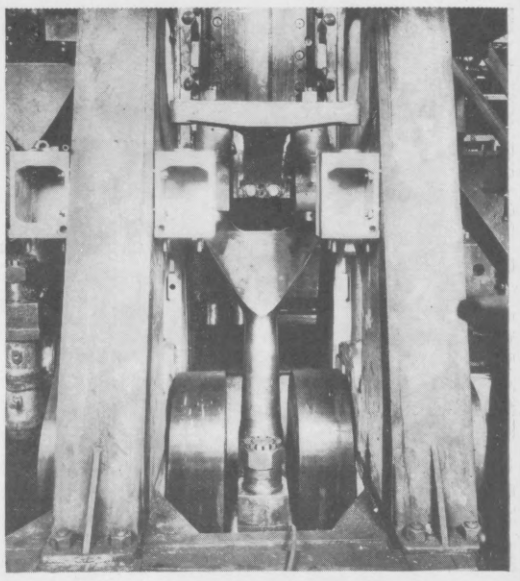


Crankshaft of the Hamilton-M.A.N. double-acting Diesel is of built-up type



Marine type connecting rod

The crankshaft is of the built-up type, and the connecting rod is of the conventional marine design. The crosshead is attached to the slipper which operates on the guide, this guide being of the single slipper type.

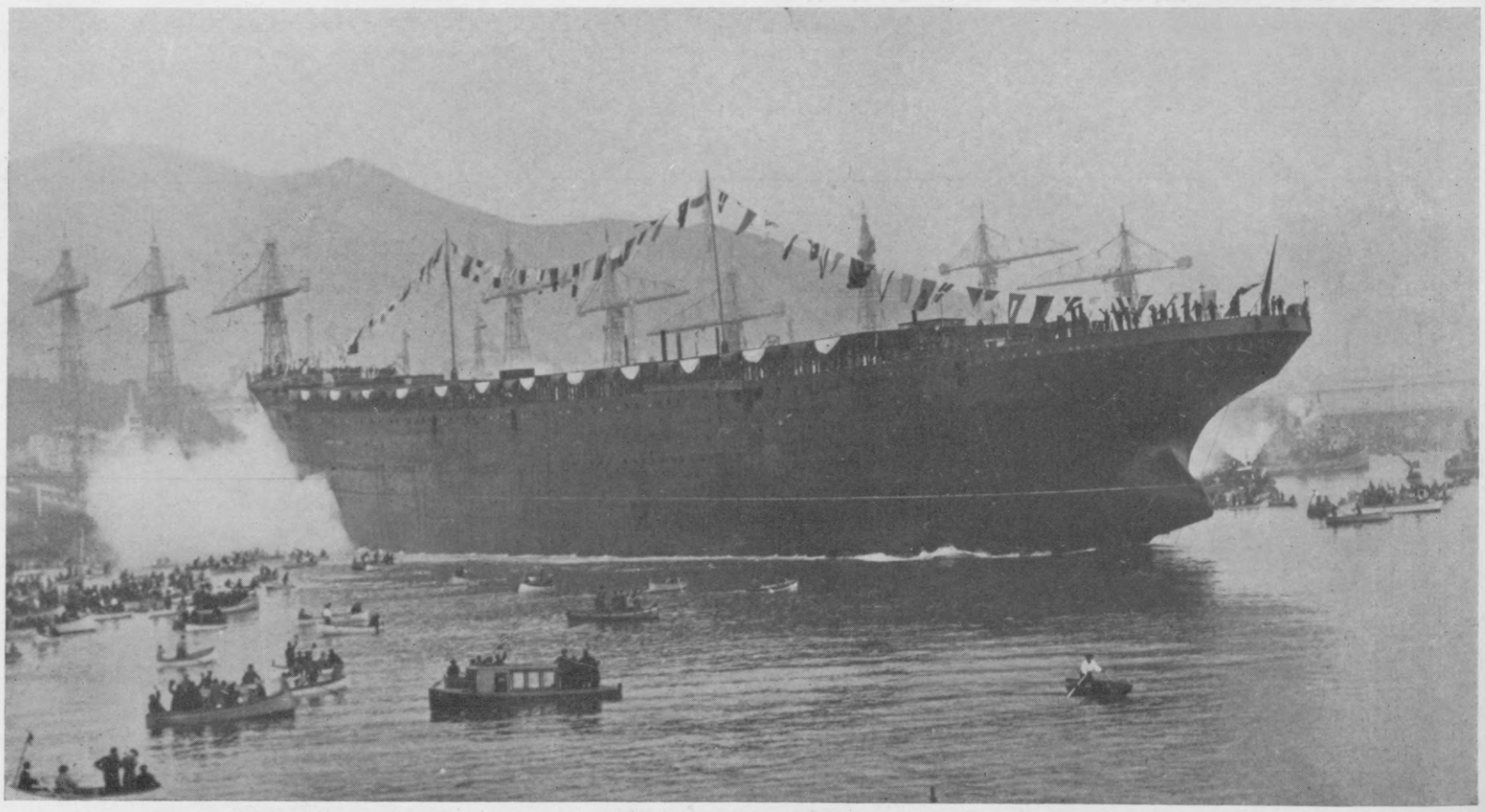
The main bearings, illustrated above, all have shims supplied by the Laminated Shim Co., Long Island City, N. Y., which are provided for adjustment in all parts subject to wear.

Cast iron is used in the engine for all the structural parts; the liners are made of special cast iron of proper hardness for resisting wear. The cylinder heads are made of cast steel and in parts so as to provide proper water circulation. The piston heads are also of steel castings and constructed so as to be of great strength with proper openings for water circulation to transmit the heat rapidly. Ohio Steel Foundry Co. were responsible for supplying the principal foundry work on the engine.

The engine's preliminary testing was satisfactorily carried out in the shops of the Hooven, Owens, Rentschler Company and it has completed the 30 days acceptance test on Feb. 12 required by the Shipping Board. Three Sharples centrifuges were used during this test, two for fuel oil purification and one for the lubricating oil service.

Although the first engine of this design was completed only a year ago, there are already under construction in this country and abroad, engines to the extent of 77,000 b.hp. Included in this program is ms. AUGUSTUS, which will be the largest motorship in the World, recently launched in Italy, equipped with four 6-cylinder main M.A.N. engines each of 7000 b.hp., a total of 28,000 b.hp. on four screws. These engines are identical in cylinder size and detail design with the engine just completed in the shops at Hamilton.

The most notable example of a M.A.N. double acting layout is the 15,000 hp. engine installed in the Hamburg Electric Light Station, Hamburg, Germany. This engine is in design exactly the same as the one the Hooven, Owens, Rentschler Company have built except that the cylinder sizes are larger being 34 in. diameter by 60 in. stroke. The engine has nine cylinders with attached compressors but separate scavenging pumps. This engine was recently subjected to fuel tests and at full load, the fuel consumption per b.hp. was found to be 0. 0.372 lb. excluding the scavenging blower. It was found to be 0.394 lb. per b.hp. including the scavenging blower. The thermal efficiency, referred to b.hp. was found to be 37.5 per cent, excluding the scavenging blower or 35.7 per cent including the blower. The engine has been in satisfactory operation for some time.



Ms. Augustus, largest passenger and mail motorliner in the world, now building in Italy, has M.A.N. double-acting 2-cycle Diesels

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Off-Peak Electric Power Costs Little—Store It for Peak Loads

On Oil-engined Boats Half a Cent per Kw.-hr. Is the Generating Cost of Spare Electric Power. This Low Cost Makes Electric Heating and Cooking Economical

IN every oil-engined boat, from the smallest tug up to the biggest liner, electric power is made available by one or more generating sets. It is unfortunate for these oil-engined generators that they have become universally known as auxiliary sets, for, being regarded as of minor importance, the full extent of their uses and possibilities has been correspondingly little studied and considered.

Very few of these boats will be found to present an exception to the rule that a certain amount of electric power can be generated for about half a cent per kw.-hr., a figure way below the price at which any electric power company on land could afford to sell. Yet this spare power remains unutilized, because its cheapness is unrecognized.

How remarkably cheap it is will only be appreciated slowly by owners of oil-engined craft. Nowhere but in the marine world could such cheap power have remained so long neglected and unused, and the reason is that the costs of auxiliary power on boats and ships are not analyzed and compared.

Study the conditions of operation applying to generator sets aboard any oil-engined boat. The power of the engines driving the generators has been determined by the peak load expected, which may be the maximum load on the maneuvering compressor equipment, the maximum load on the winches or a particular combination of loads. In the majority of oil-engined craft the peak load occurs very seldom. For long hours—sometimes for days—this machinery or a large part of it is idling, doing nothing but pile up its fixed charges.

Fuel and Lubricating Oil Only Extras

Here is a generator set which had to be installed to perform a certain function from time to time. During the rest of the time it may be entirely idle or it may be operating under light load. Its maintenance is provided for, the labor for operating it is there. How much will it cost to take more power out of it when it is running on a light load?

Let us see. Will the interest on the capital be increased? No. Will the operating labor cost more? Obviously no. Will the depreciation or maintenance be increased? Try to reckon out how they will vary between running at, say, half load and full load, and you will find you cannot get beyond a few hundredths of one cent per kw.-hr. What then will the extra power cost? Clearly, only as much as you pay for the fuel oil and lub. oil consumed. Those items for a well loaded engine running on the best part of her consumption curve amount to the average figure of half a cent per kw.-hr. already quoted above.

Electric power at this price permits you to use it for any purpose and save money over the alternative. The mere mention of electric heating causes most people to visualize exorbitant bills. True enough electric heating by and large is expensive, but it is never expensive at half a cent per kw.-hr. In the South and West electric heating is springing into wide favor ashore under the encouragement of fairly low power rates, because it is found there is never any waste through overheating when a flick of the switch suffices to shut off the service of the heat, there are no losses keeping a furnace warm and there are no pipe losses.

Electric Heating and Cooking Can Be Economical

Losses from waste heat make steam heating more expensive in practice than laboratory figures would make one believe, and the absence of such losses make electric heating relatively more efficient. When you have power at half a cent per kw.-hr. you can treat all your previous ideas of electric heating as dunnage and heave them overboard. The only limit to the electric heating is the amount of power available at this price.

Similarly with electric cooking. An electric range is not an economy if you have to pay much for power, but at half a cent per kw.-hr. it is far more economical than a coal range or oil range. Moreover, and this point is very difficult to keep in front of people although it is very important, food cooked by electricity does not lose as much weight in the process as when cooked on a coal range and of course far less than when cooked on an oil range. The oil range is the least satisfactory type of all, so far as the cooking of the food is concerned.

Heating and cooking are not the only uses for the spare electric power. Use can be made of a storage battery which, kept charged by the generator when the load is light, will give that power back to help out on peak loads or will permit the generator set to be shut down entirely at intervals.

Conditions vary greatly not only in different types of vessels, but in boats and ships of the same class. What may prove economical in one case may not save money in another case. From a brief consideration of a couple of widely divergent cases the variation of conditions will be apparent.

Spare Electric Power on a Tug

A towboat with a main engine of 200 hp. or 300 hp. invariably has a small oil engine hooked up to a compressor and perhaps to a fire and bilge pump. The generator may be connected to the small oil engine set or—as one often sees it—is independently driven by a small gasoline engine, which eats up money.

If the tug is engaged generally on long tows the independent compressor will seldom be in use, and there is no good reason to connect the generator with it because that would involve running the small engine for electric power alone. A better way would be to drive the generator by a chain from the main shafts, very satisfactory indeed in such a case because the main engine will run for long periods at a steady speed. Float a battery on the line and store all the spare power for use on peak loads or in the galley. An electric range in a towboat's galley then becomes an economy. If the tug is operating in waters where frosts are rare and only sufficient heating may be required from time to time to take the chill out of the enclosed spaces then electric heating can well be used, saving the cost of a steam heating plant and its piping and installation and saving also in the operating costs.

If that same tug is being used in short harbor tows its independent compressor will be needed often, and the small oil engine will serve best to drive the generator. Again the use of a storage battery will make electric cooking cheaper than any other method, and the same remarks apply to heating as before.

A Tug Without a Battery Is Dead

In both cases the tug will be better protected with the storage battery aboard, because when the boat is tied up the watchman can pump her out if he has only to throw a switch for that purpose, whereas with no battery aboard the boat is dead when the engineers are ashore. Another feature of the battery is that it provides lighting when the engineer shuts down and also when he goes aboard again to start up.

Prejudice against storage batteries is sometimes encountered amongst marine engineers. When that prejudice is plumbed it is found to have been born of dissatisfaction with poor batteries. A storage battery to be useful must be good. It must also be well protected by a dependable circuit breaker, for nothing is so ruinous to a battery as overloading it, unless it be the taking of power out of it when it is almost discharged. A good battery well installed and well protected lasts for years.

Spare Electric Power on Freighters

Another illustration of the neglect to use power at half a cent per kw.-hr. is found on nearly all freighters. Just because SELANDIA, the first ocean-going freighter, was equipped with so-called auxiliary compressor-generator sets, nearly every big motorship has been equipped in similar fashion without more ado. There has been

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a development in the compressor arrangement, but the general system has remained the same without any marked development until the present day.

On some Danish motorships the engine-room is locked at night in port, and from 10 p.m. till 6 a.m. a feeble flicker of light is obtained from oil lamps and candles. The thrift is commendable, but not sufficiently modernized for American habits. The American version would be to run the lights off a storage battery charged during offpeak times during the day—and even when the winches are being operated there are intervals between the peaks, not such intervals as a man need have to see, but intervals which automatic devices would take advantage of.

On the STEELVENDOR, which is in the service of the U. S. Steel Corporation on the Great Lakes and St. Lawrence, a battery is used to assist the generator set during the peak loads of the cargo cranes. This seems to have been the first experiment in this direction and it is reported to have worked out very satisfactorily in practice.

On the SEEKONK, which Cramp's converted in 1923, use was made of an automatic electric heater for the supply to the baths and wash basins. In the Shipping Board conversions this plan has been further extended, an automatic electric radiator having been installed in the carpenter's store forward and a few auxiliary pieces of apparatus in the galley and dining-room being electrically heated, besides the two automatic electric water heaters supplying hot water for the crew as well as for the officers and passengers.

These are steps in the right direction. In point of fact the log of the TAMPA (Motorship, Feb. 1927) shows that one generator set out of three is kept running continuously at sea with a total energy output that corresponds very closely to a full load all day. So far so good. That generator set is operated as it should be, but what of the two others that stand idle during the passages? Even if the engineers like to have one engine idle for inspection, valve changing etc. that leaves still one engine which should be put to work. Machinery is not purchased to stand idle, but to do work. On most vessels not even one generator set is properly loaded.

Electric Cooking Cheap at ½c. Per Kw.-hr.

Why burn oil in a galley range when power is available for an electric range? Again prejudice is rampant. Electric cooking is considered so expensive. So it is generally, but not aboard vessels where power can be had for half a cent per kw.-hr., as it can be wherever generators are standing idle. Ship's cooks are not accustomed to electric ranges and forget to turn off switches and so on, is another argument used against electric ranges. But remember that if the woeful tale that marine engineers could not operate Diesels had been accepted by everyone, there would have been no SELANDIA and no thousand other motorships too. Note also that some foreign shipowners are beginning to instal electric ranges on cargo vessels, which is significant because other countries do not as a general rule use electricity to anything like the same extent as we do here, and a foreign shipowner therefore makes a greater step forward in adopting electric cooking on a freighter than an American owner would be doing in making a similar installation.

Heating the engine room and quarters electrically on a freighter may be economical only to the extent of the spare power available. The climatic conditions to be encountered are the governing element in the determination of the maximum amount of heat to be provided. If winch operation absorbs the entire output of the generators in port there will be no spare power for electric heating then. On the other hand, in bulk carriers, such as the HENRY FORD II and BENSON FORD, the cargo is loaded and discharged by shore means, and practically the entire generator capacity is then available for electric heating in port, and less is available on the passage. These two Ford ships on the Lakes are electrically heated and use electric galley ranges.

Whatever the type of boat, be she tug, ferryboat, dredge, freighter or anything else, there is always power to be had at as low a price as power ever is generated. To find out how much of it there is to spare, during which hours it is available, when it may be cut off altogether and other circumstances connected with it should be the study of every owner of an oil-engined vessel. With that knowledge he will be fitted to enquire whether he cannot use it to perform work or render a service which is being done more expensively by some other means. The key to the economic use of machinery is to use it all the time to the fullest extent of its capacity.

In new vessels there is room for improvement in the arrangement and selection of the generating equipment. Fifteen years ago motorships were regarded as essentially twin-screw vessels largely because very few owners or engineers had quite sufficient confidence in the Diesel engine to trust to a single engine. Nowadays single-screw motorships are no longer regarded as exceptional, and in the towboat field, for instance, any arrangement other than single-screw is rare.

The confidence placed in a single propelling engine can be placed in a single generator-compressor set. Time will come when many boats will have no more than one auxiliary engine in an engine room—unless perhaps a small port lighting set is added—and the generator for sea service will be driven by the main engine with the big generator serving at sea only as a stand-by, to be used for example in fog or when very heavy weather requires the main engine to be slowed right down. In entering or leaving port, when maneuvering air is required, or in port when power is needed for the winches, the big generator set will be used. Even then there will still be spare electric power, and the economies of batteries, electric heating and cooking will still present themselves, as media for using power otherwise wasted.

Circuit Breakers Explained

ADOPTION of the I. T. E. circuit breakers on the switchboards of the TAMPA, UNICOL, WEST HONAKER, WEST CUSSETA and other motorvessels of the Shipping Board has drawn the attention of marine engineers to this important detail of electrical equipment, which is destined to enter into the motorship engineer's field more and more as the use of electricity aboard ship is extended.

A circuit breaker is the most effective safety device the electrical engineer can provide: its function is analogous to that of the pop-valves on cylinders, compressors, air flasks, air lines, etc., where excess pressures can be built up, but of course a circuit breaker, being electrical, operates faster than any mechanical device.

Circuit breakers are used most often to open a circuit in the event of excessive current. In the Ford ship EAST INDIAN and in the Shipping Board vessels they are employed on the generator circuits and on the main power circuits. They are set to open when the current through the circuit exceeds a certain overload. For example, if when only one generator is running almost up to full load an extra load of considerable magnitude be suddenly added the breaker protecting that generator will fly open, even before the instruments on the switchboard have time to register the amount of the overload. Similarly if one of the winch circuits should become overloaded through any unusual cause the circuit breaker on that line will fly open and prevent any damage through excessive currents in circuit.

In contrast with the fuse the circuit breaker is rapid and sure in action. It operates always at the predetermined overload, and if it opens several times in quick succession one may be sure there is trouble on the circuit and the cause must be discovered before the circuit breaker will stay closed. Under similar conditions the replacement of fuses might burn out an armature or give rise to other damage. A circuit breaker can, moreover, do more than provide safe protection against an overload.

I. T. E. circuit breakers are made in a number of different types to suit different conditions. The simplest type which responds directly to an overload can have features added to it, such as an attachment for opening the circuit breaker in case the voltage drops too far below normal, or an attachment to discriminate between an overload of very short duration and a continued overload, or an attachment to open the circuit breaker on a reversal of current.

These various features are known as "no voltage," "time limit" and "reverse current" features respectively. The "time limit" can take care, for example, of the greatly increased currents that pass for short periods through motors when starting. The "reverse current" feature has such applications as the prevention of the flow of current from one generator to another when generators are running in parallel or from a battery to a generator when a battery is being charged, in both of which cases a loafing engine could be covered up.

It becomes worth while for all those having to do with the planning, selection, ordering or operation of marine electrical equipment to make themselves acquainted with the uses of circuit breakers. A very good way to acquire this knowledge is from the excellent publications on this subject which may be obtained free from the Cutter Electrical & Mfg. Co., Philadelphia.

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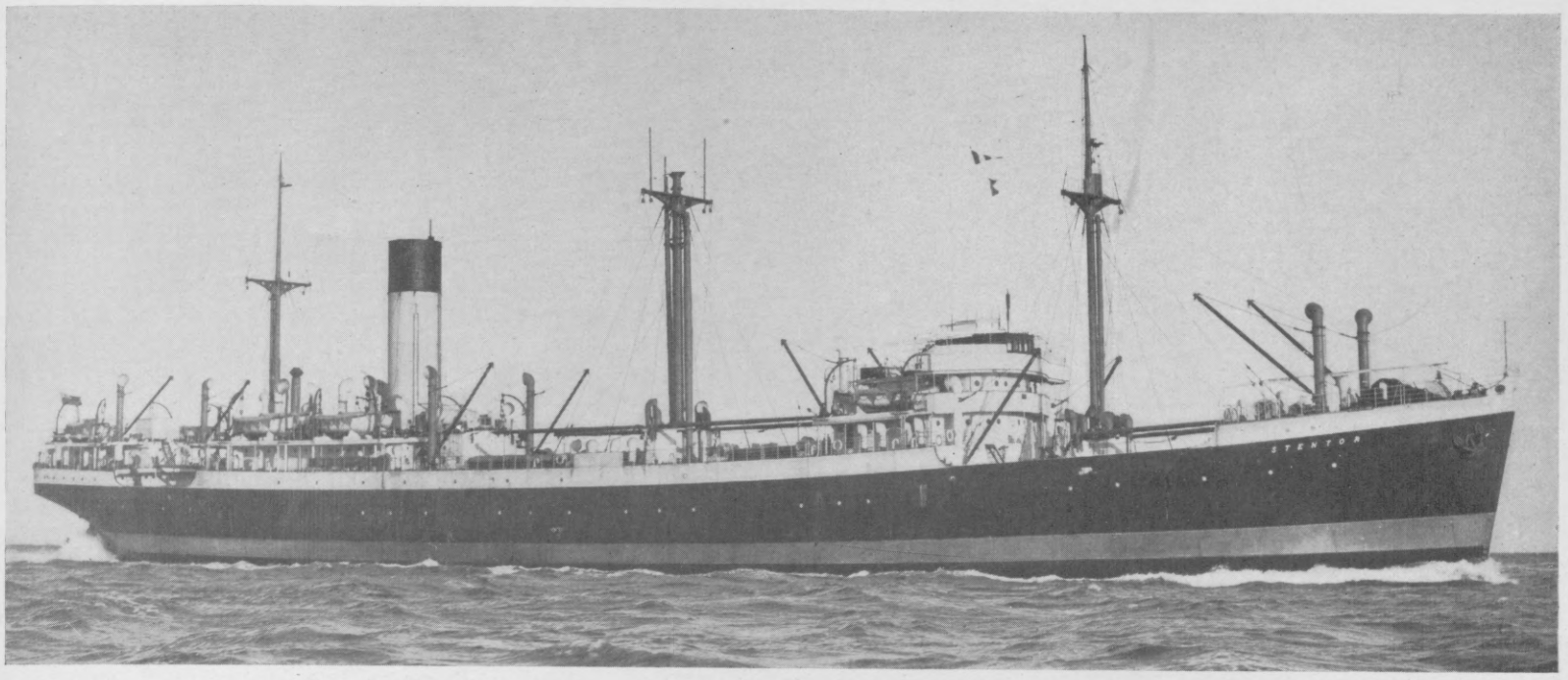
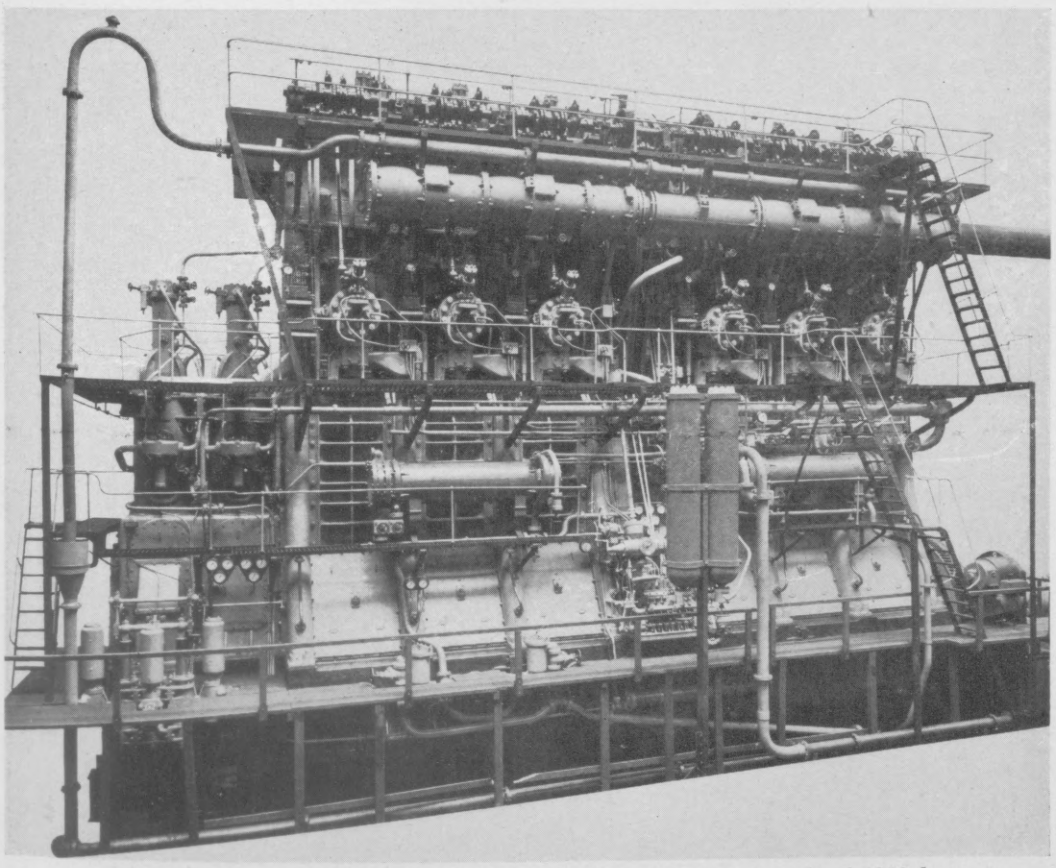


Ms. Stentor, a High Speed Motor Freighter

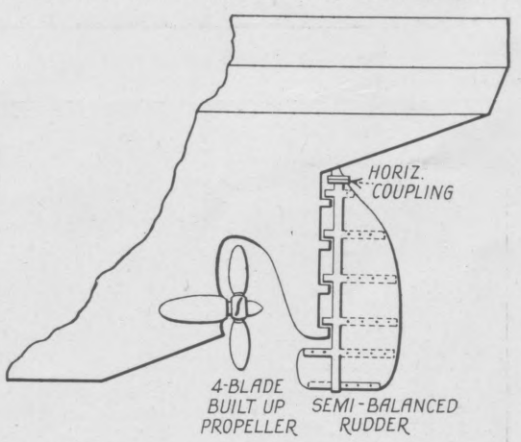
Powerful New Vessel, Representing Last Word in Freight Ship Design Has Double-acting Diesel of 4000 hp.

MS. STENTOR, one of the latest additions to the rapidly growing fleet of motor freighters owned and operated by Alfred Holt & Co., Liverpool, is propelled by a 6-cylinder double-acting 4-cycle Diesel of Werkspoor type constructed by the North Eastern Marine Engineering Co., Wallsend-on-Tyne, England. This engine has cylinders 32½ in diameter by 59 in. stroke and is rated at 4000 b.hp. at 95 r.p.m. At this speed it gives the ship, loaded, a service speed of about 13½ knots, and is direct connected to a 4-blade built up propeller running in a part stern frame aperture of the special type illustrated herewith in our sketch.

We do not recall having seen this arrangement before and its fitting to a modern motorship certainly is in line with the progressive spirit displayed by this big Liverpool firm of shipowners. The absence of deadwood is particularly noticeable and in addition the designers have succeeded in eliminating all portions of the stern frame of stereotyped outline, which while necessary, maybe, for strength considerations are simply adding to the total resistance of the ship. Thus actually the new arrangement shows a stern frame without bottom and part of the back—in effect an arrangement somewhat reminiscent of that adopted when the Flettner rudder is fitted. The cutting away of a certain amount of deadwood, too, and the semi-balanced rudder should materially improve the steering.



Ms. Stentor's main engine, a 6-cylinder double-acting 4-cycle unit of 4000 hp.



Novel arrangement of stern

This arrangement gives us one more lesson in the theory that the motorship is an all round improvement in the steamer. It is a new thing, incorporating new ideas.

Ms. STENTOR has a short stumpy forecastle, long bridge deck or center castle as Alfred Holt Co. generally terms it, and poop. She has a length b.p. of 425 ft. 0 in. a beam molded of 55 ft. 6 in., a depth molded of 31 ft. 0 in., and a mean draft of 26 ft. 0 in. Her gross register tonnage is 6500 tons. There are in all five main holds, four forward and one abaft the machinery space. One of these holds is also a deep tank. All the deck and engine room machinery is electrically driven.

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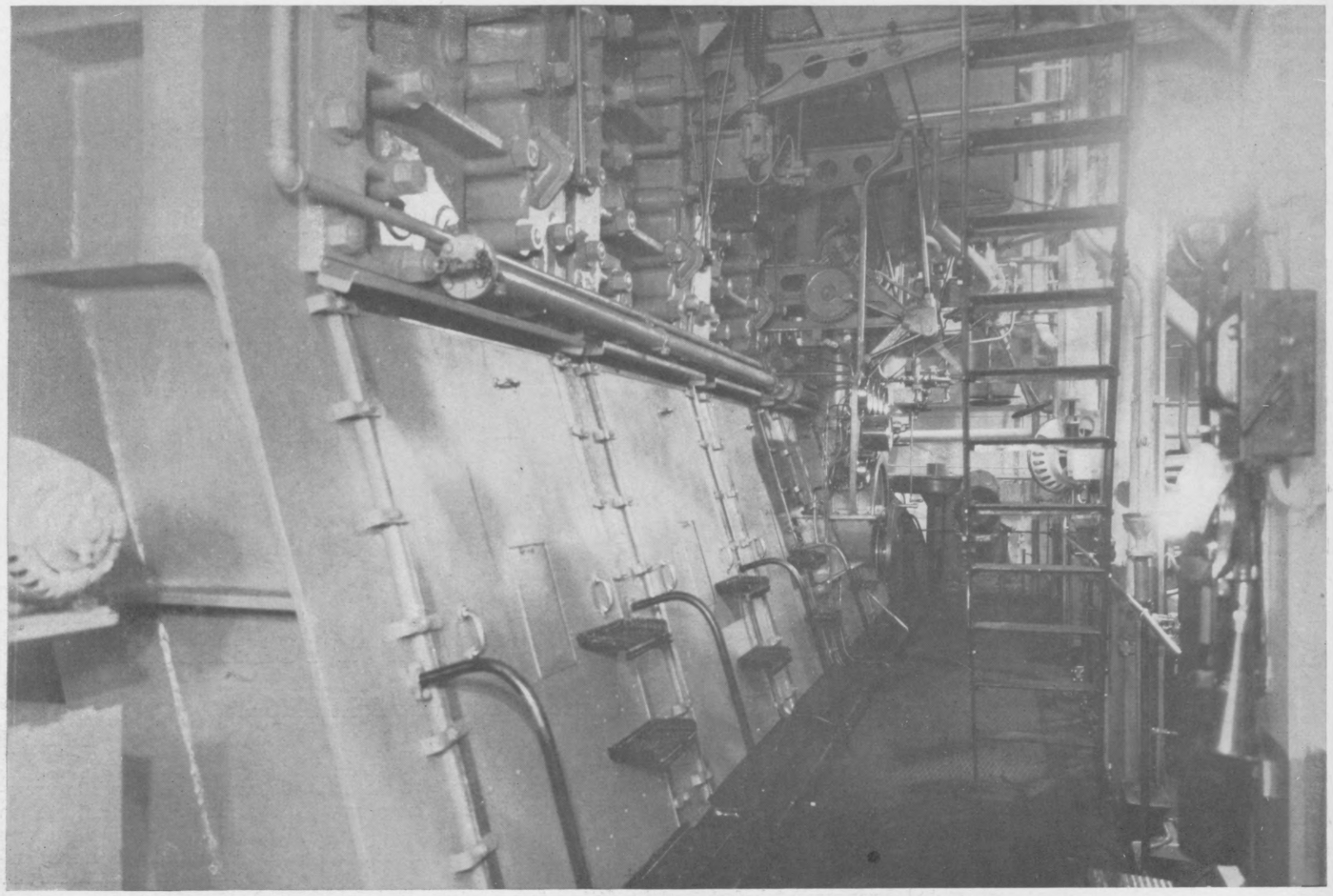
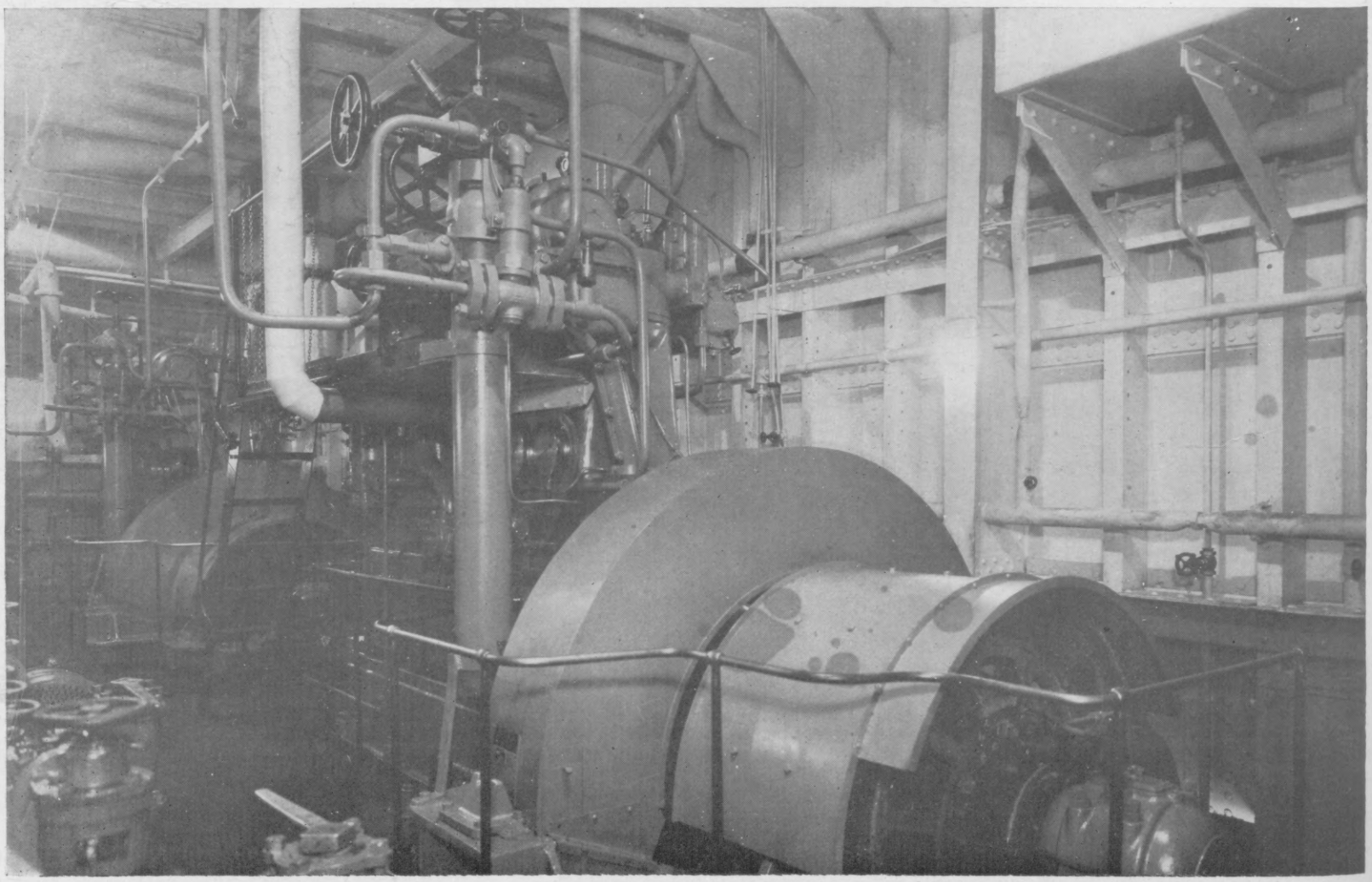


Side view of the main 2700 hp. McIntosh and Seymour Diesel on West Honaker type converted Shipping Board motorships



Ms. West Honaker, West Cusseta, and the newly completed Crown City have all the same arrangement of auxiliary machinery

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Shipping Board Motorships Are Economical

Ms. West Honaker Now in Service to India and Australia Shows Fine Results in Transatlantic Voyage

WHEN the converted Shipping Board motorship WEST HONAKER left her pier at Brooklyn on February 19 outward bound with a general cargo for Sydney, Melbourne, Adelaide and Freemantle she added to the ever increasing fleet of modern well equipped motorships engaged in Round-the-World trade. Her voyage outward to Australian ports via Panama will be continued homeward via Indian ports and the Suez Canal in accordance with the schedule outlined by Kermit Roosevelt in his article published in the February issue of MOTORSHIP. The Roosevelt Steamship Co. at present operates ms. WEST HONAKER and her sister ms. WEST CUSSETA, both of which are powered by a 6-cylinder McIntosh and Seymour Diesel rated for 2700 at 95 r.p.m. Ms. CROWN CITY, a third vessel fitted with this type of engines and like her two prototypes converted at the Bethlehem Fore River Plant, ran her acceptance trials in February.

Ms. WEST CUSSETA went straight on her long Australian voyage from her converter's yard—surely a splendid tribute to the confidence generally felt in the performance of her engine—but ms. WEST HONAKER after completing successfully her trial proceeded straight to Charleston, S. C., where she loaded a cargo of cotton for Bremen, Germany. She returned light from this port straight to New York where a start was made with the loading of her general cargo for Australian ports.

Performance of the ship on this transatlantic voyage in the December-January period when weather may be responsible for all sorts of delays left nothing to be desired, and as was the case with ms. TAMPA, the engine room on the ship's return to New York was a model of cleanliness and orderliness.

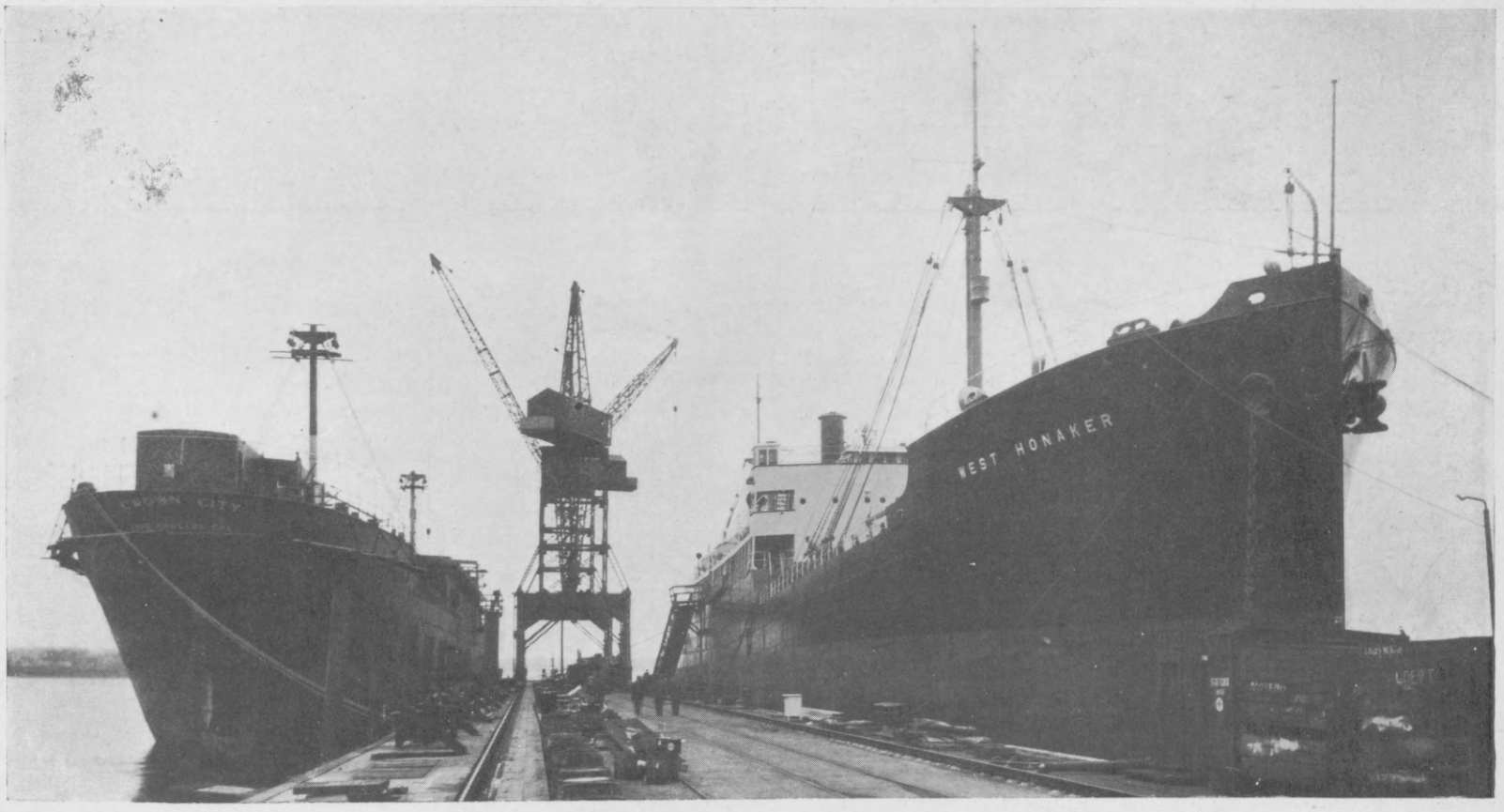
Characteristics of ms. West Honakar

Gross tonnage	5,428 tons
Net tonnage	3,374 tons
Length overall	423 ft. 9 in.
Length b.p.	410 ft. 0 in.
Beam, molded	54 ft. 0 in.
Depth, molded to upper (main) dk.	29 ft. 9 in.
Displacement, load	12,086 tons
Draft at above	23 ft. 11¼ in.
Displacement, light	4,080 tons
Draft, light	8 ft. 10 in.
Power, main engine	2,700 b.hp.
Service speed, about	11 knots
Endurance	17,600 miles
Total deadweight capacity	8,006 tons

On the outward voyage, the total distance between pilot stations—Charleston lightvessel to the Weser lightvessel was covered in 15 days, 21 hr., 30 min. The ship had a mean displacement of 9137.5 tons on the passage, some 2900 tons short of her full load displacement, accounted for by the fact that although she carried a full cargo of cotton, this did not put her down to her marks. Between pilot stations the engines ran at an average speed of 90.18 r.p.m. giving the ship an average speed of 10.68 knots. It is to be noted, however, that under favorable weather conditions the speed rose on the second day of the passage to 13.6 knots with an observed day's run of 315 miles. This speed and distance is easily comparable with performances of some of the fast Round-the-World freighters now in service.

Total fuel consumed for the passage, pilot station to pilot station, was 1545 bbl. which works out at 38.6 bbl. per 100 sea miles. For winch operation and other standby duties in Bremen a total of 59 tons was expended. The machinery functioned perfectly through the passage, and the only inconvenience experienced was that due to a leaky I.P. suction valve on the independent air compressor. This necessitated starting up one of the auxiliary sets and the two sets were run alternately for the rest of the passage.

Homeward, considerably better weather was encountered and the ship made the distance between the Weser light and Ambrose Channel Lightvessel in 15 days, 9 hr., 17 min. She had a mean voyage displacement of 6070.5 tons and a mean draft on arrival of 11 ft. 6½ in. An average speed of 11.73 knots was registered and the speed only dropped below 11 knots for one day on the passage, at which time the ship was punching into a heavy head swell with considerable racing of the engines. The slip on this day was as high as 14 per cent. Total fuel consumed, pilot station to pilot station, was 1307 bbl. or 30.17 bbl. per 100 sea miles. Engines were turning at an average speed of 93.6 r.p.m.



Ms. West Honaker, fresh from her converter's yard, carried out a noteworthy maiden transatlantic voyage

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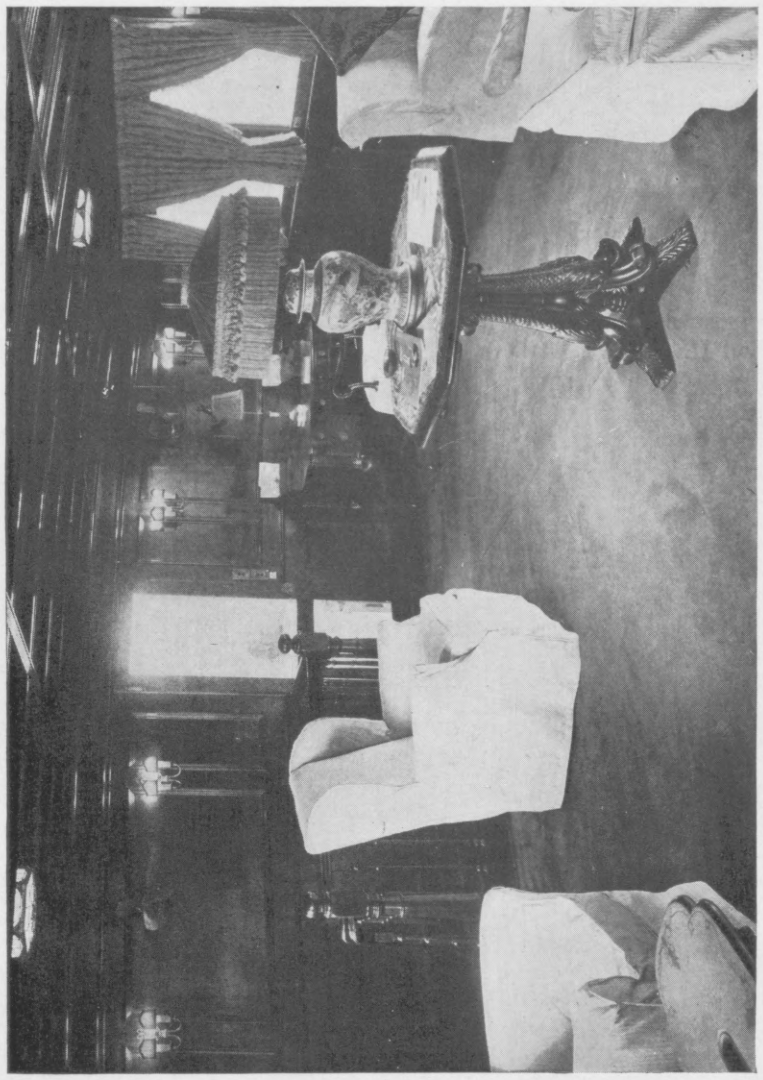
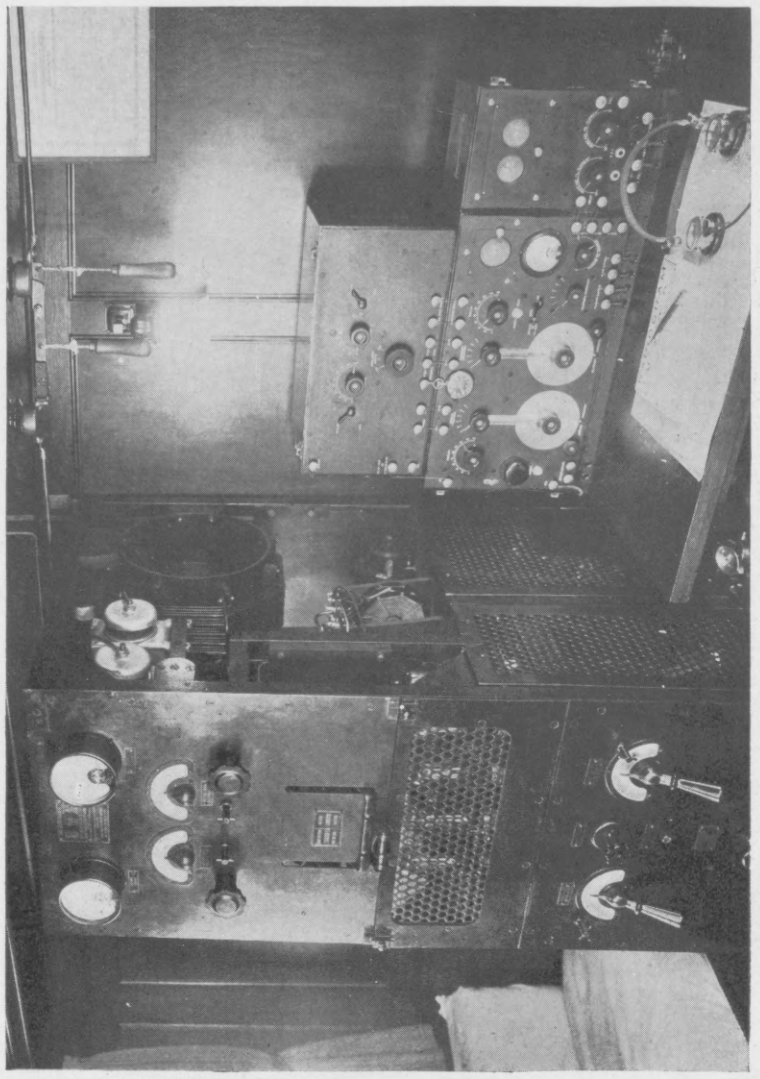
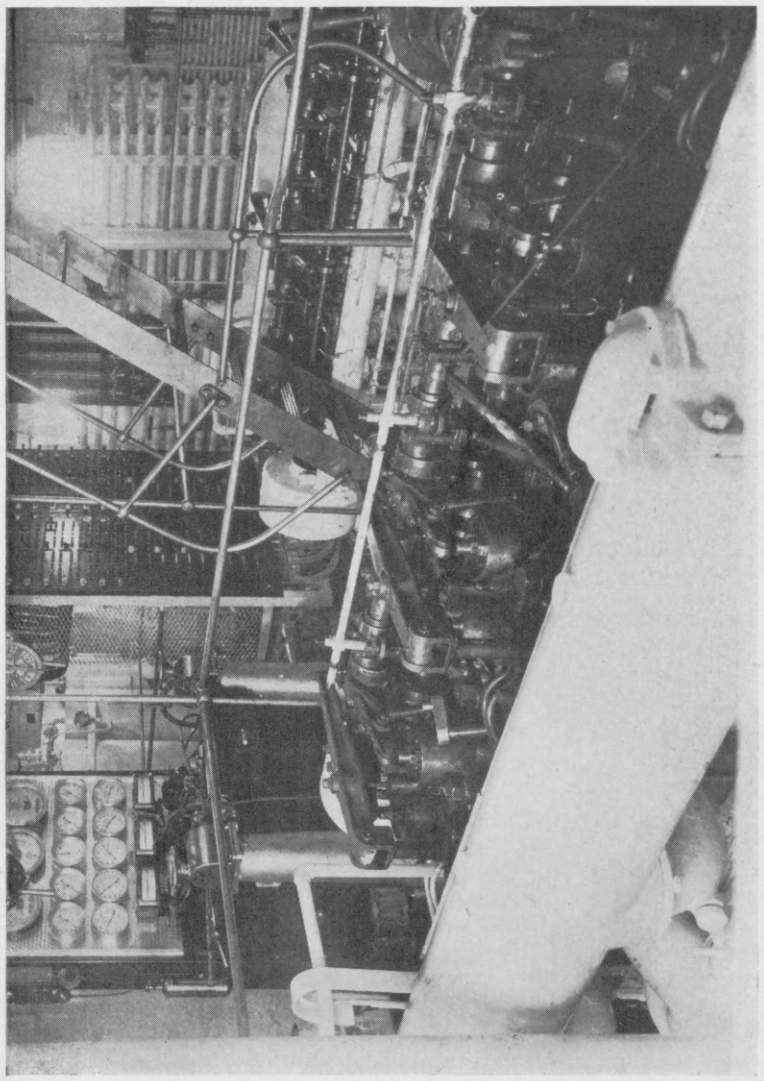


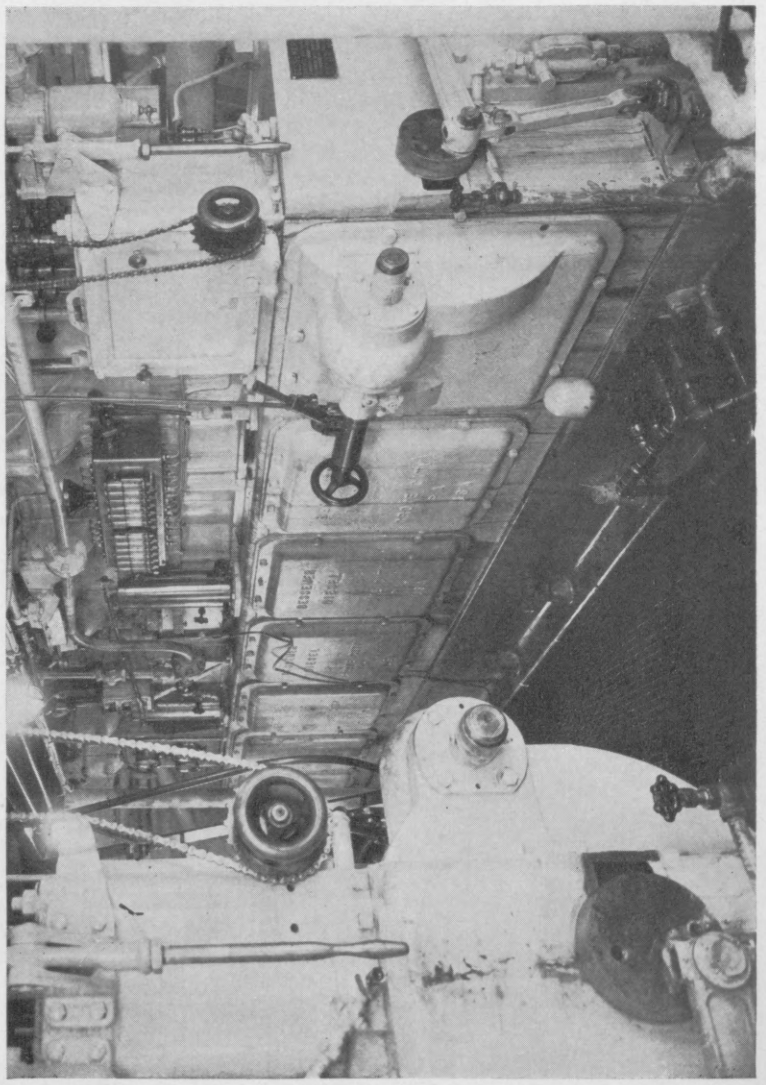
Shows the comfortable luxuriousness which characterizes Sumar's accommodation



Long distance radio equipment is naturally included in the equipment



Cruising power for 9500 miles is contained in motoryacht Sumar's compact machinery space



Two 6-cylinder 420 hp. Diesels form the main propelling plant

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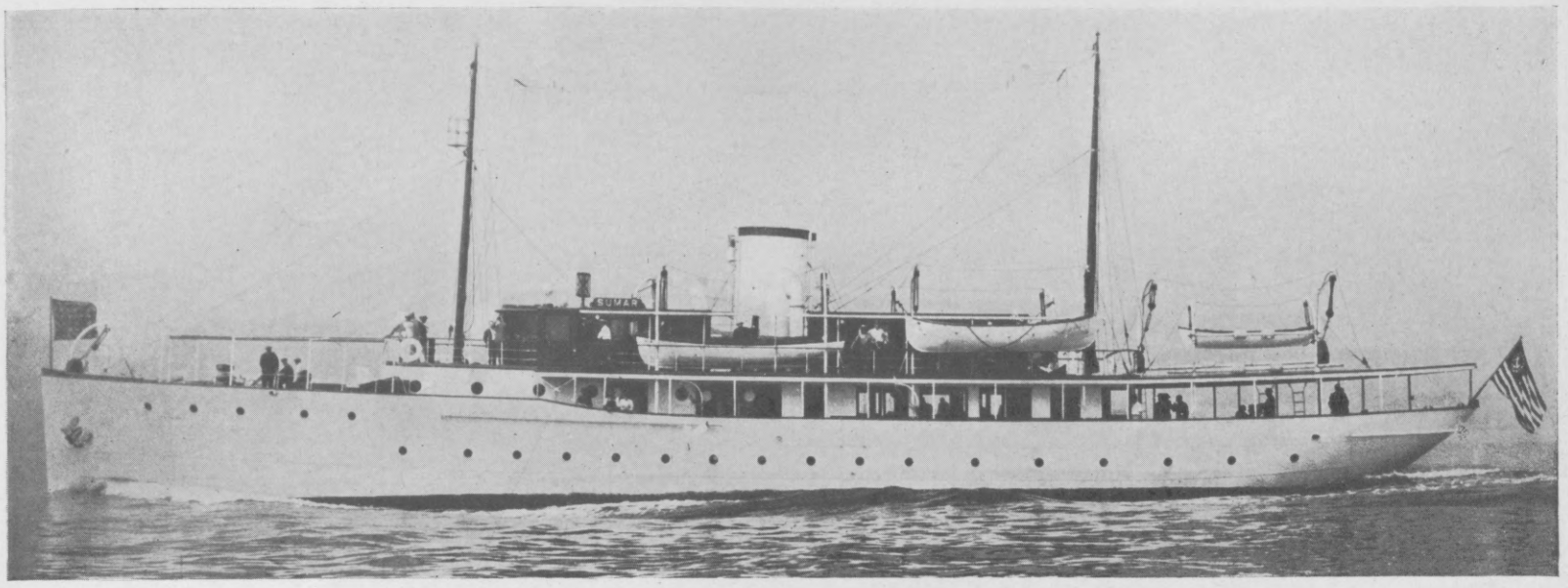


Motoryacht Sumar Now Ocean Cruising

Has Left New York for a 40,000 Mile Round the World Cruise Rendered Possible by Her 840 hp. Diesels

A RECENT addition to the rapidly growing fleet of yachts demonstrating the suitability of Diesel engines for propulsion is the Gielow-designed Todd-built SUMAR which her owner, David C. Whitney of Detroit is now employing on a round the world cruise.

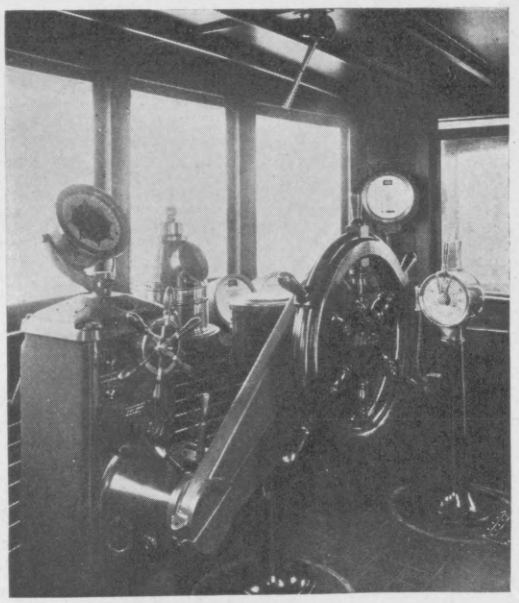
In conformity with the dictates of prevailing fashion in yacht design, SUMAR has a straight stem, very little sheer and a brief counter. A deckhouse extends aft from a built-in forecastle and the deckhouse top is continued to the stern in the form of an awning. On the deckhouse top are two small houses, one forward and one abaft the stack, containing the pilot house, captain's quarters, and the radio room and a large shelter open towards the stern of the ship respectively. The stack is the most striking feature of the ship. It is squat in appearance and of flat oval section. A narrow black band around the top acentuates the squat appearance and the result is that the ship presents a profile which suggests speed combined with sturdiness.

Characteristics of Sumar

Length overall	160 ft. 0 in.
Length l.w.l.	152 ft. 6 in.
Beam, molded	26 ft. 0 in.
Draft	12 ft. 0 in.
Power (total)	840 b.hp.
Speed (trial trip)	14 knots
No. of main engines	2

SUMAR is powered by two 6-cylinder, 420 b.hp. Bessemer Diesels each direct coupled to a propeller. Fuel capacity is supplied for these engines to permit of a cruising radius of 9500 miles, the vessel having been specially designed with an eye to ocean cruising work. SUMAR in fact has made a cruise to and through the Mediterranean this fall, and is now crossing the Pacific Ocean enroute for Atlantic waters via Honolulu after which she goes to the Mediterranean via Suez. This big cruise will extend into the middle of 1928.

The main engines are arranged in a compact engine room where also are fitted two 40-kw. Bessemer auxiliary Diesels in addition to a complete range of other auxiliaries necessary for the operation of the ship. There are ten silencers all of Maxim type, two 8-in. units on the main engine exhausts, two 4-in. units on the auxiliary engine exhausts, two 6-in. units on the scavenge air intakes of the main engines,



Metal mike in wheelhouse

two 3 in. units on the scavenge air intakes to the auxiliary engines and two 1-in. units on the suctions of the main engine air compressors. There are four lubricating and fuel oil pumps of Viking type, and two Kewanee fresh and salt water service pumps, three centrifugal pumps for fire, general service and bilge purposes, these units being of Nash type, and a vacuum heating pump, also of the same make. The main and auxiliary engines are fitted with pyrometers of Brown type. On the main engine there are also two Manzel 12-feed lubricators. There is a Brunswick Kroeschell ice machine with two centrifugal pumps driven by Diehl motors attached, Cutler Hammer controls being used. The engine room also is fitted with an emergency air compressor supplied by the U. S. Air Compressor Company. Fuel oil is passed through two Sharples centrifugal purifiers on its way from the settling tanks to the main engines. Goodrich-Cutless rubber bearings are fitted to the two tail shafts.

On the main deck is a continuous steel deckhouse containing at the forward end a dining saloon finished in walnut panelling. The pantry and galley is just abaft this, and there is an inside passageway from the dining room aft to the living room, which is also finished in walnut. The upper deck has two teak deckhouses, the forward one containing pilot house and captain's staterooms and the aft one housing radio equipment and operators' room, and Sperry gyro master compass equipment. The pilot house is exceptionally completely fitted out and in addition to the Kolster radio compass and gyro compass has an ordinary Kelvin magnetic compass and a Sperry course recorder. There is a 250,000 cp. Sperry searchlight and two Sperry floodlights, while a Sperry visible whistle is attached to the stack.

All deck equipment has been supplied by The American Engineering Co.

Sale of the Tanker CHESTNUT HILL to the Anglo-Chilean Consolidated Nitrate Corporation of New York for the sum of $57,000 is approved by the Shipping Board. Under the terms of the sale the purchaser agrees to convert the vessel to direct Diesel propulsion. Bids received for the tanker BRANDYWINE, a sister ship, were rejected.

Gulf Refining Co. is building at Furness Sb. Co., Middlesboro, England, three 1500 ton Isherwood Bracketless motor tankers powered by a Doxford engine of 3250 b.hp.

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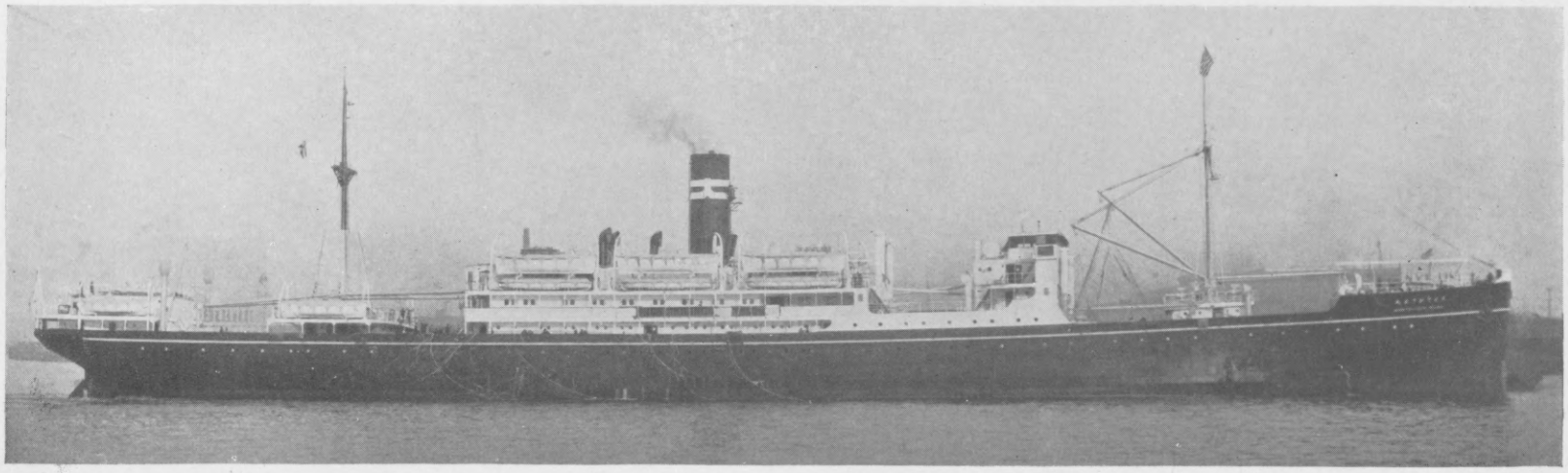


Round the World Passenger-Cargo Fleet

Japanese Company Operating Fast Motorships From Far East to South African, South American, and Gulf Ports

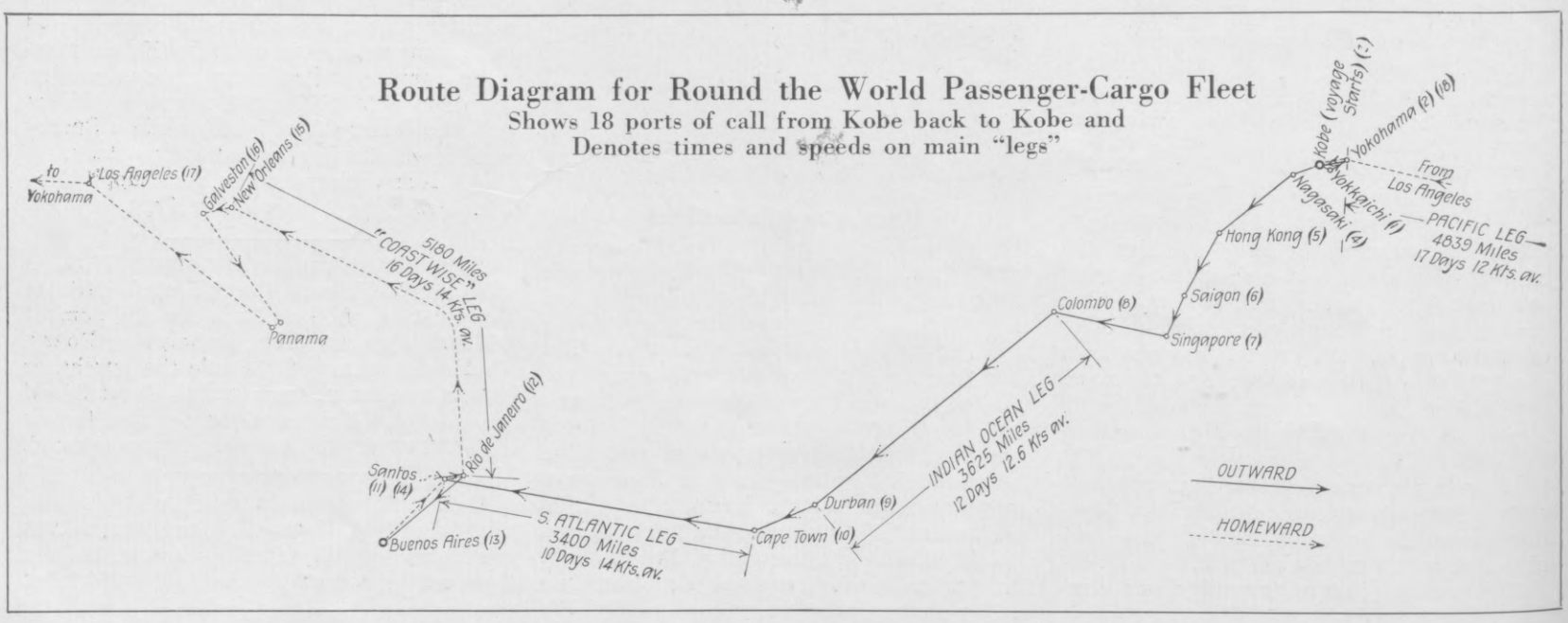
THE arrival at Kobe on Jan. 24th of the Japanese motorship MONTEVIDEO MARU marked the completion of voyage No. 1 of this 7000 tons gross motorship powered by Japanese built Sulzer Diesels of 4600 b.hp. This vessel, owned and operated by Osaka Shosen Kaisha left Los Angeles on Jan. 4, on the last leg of a round-the-world service which originates in Japan, continues via Straits Settlements and South Africa to South America, whence the route goes to New Orleans and Galveston, thence via Panama to Los Angeles and so back to Japan. The service is at present maintained by Ms. MONTEVIDEO MARU and two sister motorships SANTOS MARU and LA PLATA MARU, in conjunction with two steamers HAWAII MARU and MANILA MARU, both of which latter are slated to be taken off the route as soon as they can be replaced by new fast motorships. Here then is a round-the-world service which, like the majority of existing similar services is almost exclusively a motorship one, except that it neither commences nor terminates in New York, nor uses Suez Canal and the Mediterranean.

The service was commenced in 1916 in order to establish a direct communication between Japan and South America via South African ports, carrying merchandise and passengers from Japanese ports as well as from the ports of call. Starting from Kobe the vessels run to Yokkaichi, then to Yokohama, then back again to Kobe, after which the Far Eastern ports of call are Nagasaki, Hongkong, Saigon, Singapore and Colombo. From Colombo the vessels make a long run across the Indian Ocean to Durban, which distance is covered in about 12 days. The three motorships on the service stay exactly one day in Durban, but the steamers, presumably for bunkering purposes, are compelled to stay for 3 days. Cape Town is the next port of call and after leaving here the ships run a South Atlantic leg to Santos, Brazil, which is reached 10 days after leaving the Cape. Santos, Rio de Janeiro and Buenos Aires are all touched at for cargo discharge purposes and the latter port is officially the terminal of the outward portion of the voyage. The vessels stay here loading and unloading for about 10 days and then proceed to Santos and Rio de Janeiro for coffee cargoes, which they run straight up to New Orleans. American cargo is loaded at New Orleans, Galveston and Los Angeles, which is the last port of call before Yokohama. These motorships by their superior speed and efficiency can deliver coffee at New Orleans in record time and have made serious inroads on the steamer business in this trade.

Seventeen days are taken to cross the

Characteristics of Ms. Montevideo Maru

Length overall	448 ft. 9 in.
Beam molded	56 ft. 0 in.
Depth molded to shelter deck	36 ft. 0 in.
Draft load	25 ft. 0 in.
Displacement at above	12184 tons
Gross tonnage	7267 tons
Net tonnage	4386 tons
Deadweight capacity	6800 tons
Service speed	about 14 knots
Number of tiers 'tween decks	2
First-class passengers	40
Second-class passengers	102
Steerage passengers	688
Power, main engine	4600 b.hp.
Speed, main engine	112 r.p.m.



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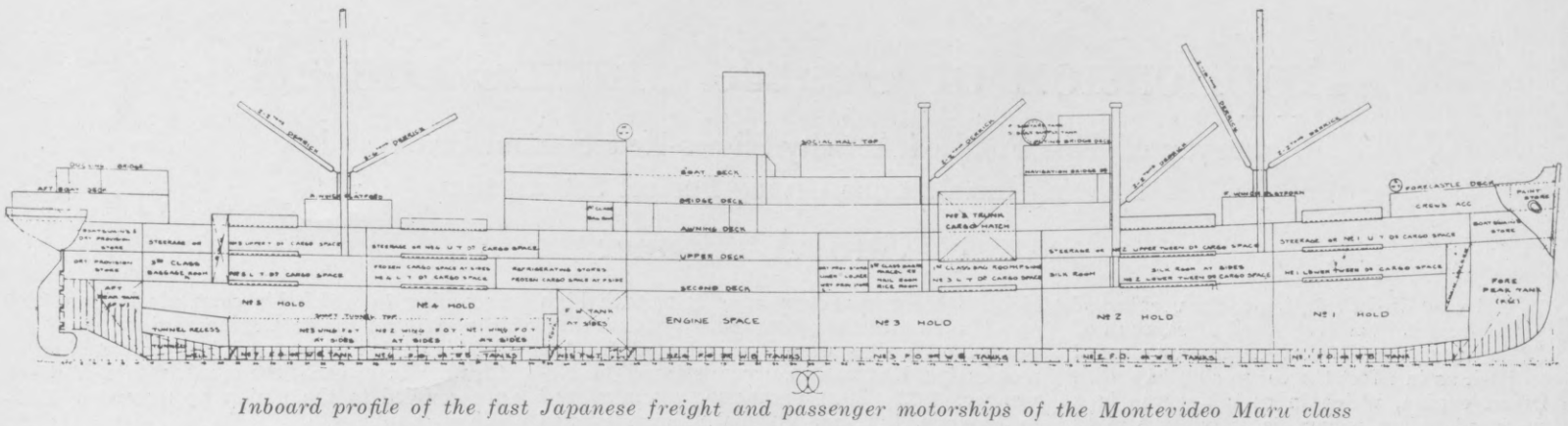

Inboard profile of the fast Japanese freight and passenger motorships of the Montevideo Maru class

Pacific to Yokohama and from this port the vessels proceed on to Kobe, thus completing the round trip. A voyage such as this demands the best of ships and the most reliable of engines. There are long cross-ocean legs and variations in climate, in temperature, and in weather.

Ms. MONTEVIDEO MARU and her two sisters can make, if necessary, between 15 and 16 knots and for that reason they rank among the fastest motorships in the world. They run at 14 knots between the Cape and Santos because their passenger list is then fullest, and between Santos and New Orleans on account of the coffee trade. Accommodations are provided for 40 first-class, 102 second and 688 immigrant passengers. In fact, it was the immigrant trade between Japan and South America which largely influenced the construction of the ships. Structurally the vessels are of shelter deck type with a short topgallant forecastle. A bridge house amidships accommodates first-class passengers on the bridge deck and on the promenade deck in comfortable two-berth cabins.

Propulsion is effected by two 6-cylinder Mitsubishi-Sulzer Diesels. These engines were constructed entirely in Japan, while those of the two sister vessels, SANTOS MARU and LA PLATA MARU, were built at Sulzer Bros. works in Switzerland and shipped out to the shipyard. In all three ships, however, the engines are the same, and have a total power of 4600 b. hp. which is developed at 112 r.p.m.

Scavenge air is supplied by two electrical driven blowers, each running at about 2500 r.p.m. Each main engine drives its own injection compressor from a forward extension of the crankshaft.

The main engines are arranged in a compact machinery space slightly abaft amidships. There are in all three auxiliary Diesel generator sets, each driven by a 250 b.hp. Sulzer engine. These are of 150 kw. output and are arranged two on the port side and one on the starboard side of the main engines. The usual pumps are arranged in the engine-room wing. Some of these are of Sulzer Bros. make, while others are of Weir & Drysdale manufacture. Centrifugal purifiers are used for both fuel oil and lubricating oil, and these are all of De Laval type. An auxiliary boiler is used for heating the ship and fuel tanks.

MONTEVIDEO MARU and her two sister ships are remarkably fine vessels. They are among the fastest motorvessels in the world and the service upon which they are engaged is a particularly arduous one. The owners must certainly be congratulated upon their realization of the potentialities of Diesel powered intermediate passenger and freight ships for a service such as this, and the fact that more ships are contemplated for the service seems to indicate that they are well satisfied with their choice.

Japan has been later than many other nations in her adoption of the motorship, but recent construction indicates that, although tardy, her interest in Diesel propulsion is nevertheless keen.

On her last arrival at Sydney, N. S. W. the big transpacific motorliner AORANGI had then run 201,042 miles in 2 years and 8 days since leaving Southampton, England, on her maiden trip. It is understood she is laying off for one trip on her arrival at Sydney because it is the slack season for traffic and a smaller boat can take the run just as well. It is rumored that the company is altering some of the staterooms, making them larger, and it may be that this will be undertaken now.

Pacific Coast—India Motorships

A NEW transpacific motorship service will be established on March 11th by Kerr Lines when their 8100 ton dwt. Doxford-engined freighter SILVERAY sails from Los Angeles direct for the Dutch East Indies, omitting calls at Japanese, China, and Phillipine Ports. The new line, it is announced through the General Steamship Corporation, Pacific Coast general agents of Kerr Lines Ltd. will be known as the Pacific Coast Java-Calcutta Line, and is a revision of the itinerary originally established by the transpacific service of the Kerr Line from San Francisco and Los Angeles. Kerr Lines have gone into the transpacific trade (in addition to the Round the World trade) since the release of its existing 11½ knot motor freighters by a fleet of 14 knotters which are being added to the fleet as fast as the builders can deliver them.

The direct service to India, it is announced, will be the first the Pacific Coast has had since the Shipping Board's round-the-world service, operated by the old Pacific Mail was discontinued several years ago. By routing its steamers straight from the Pacific Coast to Java, the new line offers a service which has not existed since the Java-Pacific line withdrew in 1923. The new schedule will call for 29 days from San Francisco to Macassar, 32 days to Soerabaya, 45 days to Singapore and 50 days to Calcutta.

Beginning with the motorship SILVERFIR from Los Angeles March 11, and San Francisco March 18, the "Silver" ships will omit calls at Kobe, Shanghai, Hongkong and Manila and sail direct for Macassar, Soerabaya, Samarang, Batavia, Belawandeli, Singapore, Penang and Port Swettenham, in the order named. The two last named ports are in addition to the existing list of call ports. The SILVERAY sailing mid-May, will extend the service to Calcutta.

$15,000,000 for Motorliners

An up-to-date passenger and mail service between San Francisco and the Orient will be instituted early in 1928 when Nippon Yusen Kaisha completes three 16,500 tons gross 19 knot motorliners. The new ships, for which contracts have been awarded to Japanese shipyards will have a length of 580 ft., a beam of 73 ft. and a load draft of 42 ft. 6 in. Each ship will carry 200 first class, 100 second class, and 400 third class passengers, and there will be capacity for 3000 tons of freight and insulated space for 500 tons of cargo. Two of the ships will have Mitsubusni-Sulzer single-acting 2-cycle engines, while the third will have B. & W. double-acting 4-cycle engines constructed by the Kawasaki Dockyard at Kobe.

The $15,000,000 for construction of these ships is, it is understood, to be furnished out of the N. Y. K. reserve fund and not by the flotation of a bond issue as was originally announced.

The chief competitors of the new N. Y. K. motorliners will be the big Canadian Pacific "Empress" vessels from Vancouver. These are fine turbine driven ships which will now need to be very economically operated in order to compete successfully with the new Diesel driven ships. N. Y. K.'s transpacific service is at present maintained by five ships of about the same size as the proposed new vessels, originally owned by the Toyo Kisen Kabushiki Kaisha before that concern was absorbed by the N. Y. K.

The Port of Charleston, South Carolina, announces, for 1926, foreign trade in the amount of $48,836,004.

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Application of Geared Marine Diesels

Survey of This Field of Activity Shows New Sets on Order and Existing Installations Giving Perfect Satisfaction

By Otto A. Banner*

ONE very direct solution to the problem of co-relating the best speed of rotation of a propeller of slow or average speed type, such as in effect the cargo ship has, with a Diesel engine, which in certain types is a high speed prime mover, is to make use of mechanical reduction gearing. This arrangement has many advantages and permits of certain economies, which well repay a detailed examination. We must always recall that American enterprise had a great deal to do with early developments in this direction. One of the first geared oil engine drive installations to appear on the high seas in a sizable ship was installed in the cargo motorship JAMES TIMPSON, a wooden ship of 3600 dwt. capacity, built in 1918. She had a length of 260 ft., a breadth of 44 ft., and a depth of 25 ft. She was a twin-screw ship and powered with two 6-cylinder Winton Diesels, each developing 500 b.hp. at 300 r.p.m. The speed of the two propellers was 100 r.p.m. and the reduction gears were standard 26 in. center gear units, ring lubricated and built by the Falk Corporation of Milwaukee, Wis. The pinions had 40 teeth and the gears 119 teeth. Two D.P. Falk Co.'s 15 in. face, rolling mill type leather ring couplings were fitted between the engine the crankshafts and pinions, as well as between the low speed gears and propeller shafts.

Another sea-going motorship having her propellers operated through reduction gears and completed about this time was the twin-screw wooden cargo vessel LIBBY MAINE of 2600 dwt. capacity. She has 226 ft. overall length, a beam of 44.1 ft., and a depth of 20.6 ft., and is fitted with two 6-cylinder 320 b.hp. Dow Diesel engines, running at 250 r.p.m., the propeller speed being 100 r.p.m. Again the gear units were made by The Falk Corporation and are of standard rolling mill type with ring lubrication. The pinions have 31 teeth, the gears 77 teeth, 2 D.P., and the face width is 16 in. This gear unit was built under Lloyd's inspection.

Both these ships were wooden structures built during the rush of the war. JAMES TIMPSON was abandoned in December, 1924. in a hurricane, after having completed 190,000 miles at sea. LIBBY MAINE is at the time of writing in satisfactory operation.

Germany has always been a particularly active sponsor of geared Diesel drive due possibly to the tremendous experience with high speed submarine engines the war gave her. Geared oil engine drive was adopted for the motorships HAVELLAND, commissioned in November, 1921, MUENSTERLAND, commissioned in January, 1922, and VOGTLAND, commissioned October, 1924. All these three twin-screw ships have a total dwt. capacity of 10,235 tons and a propeller power of 3300 s.hp.

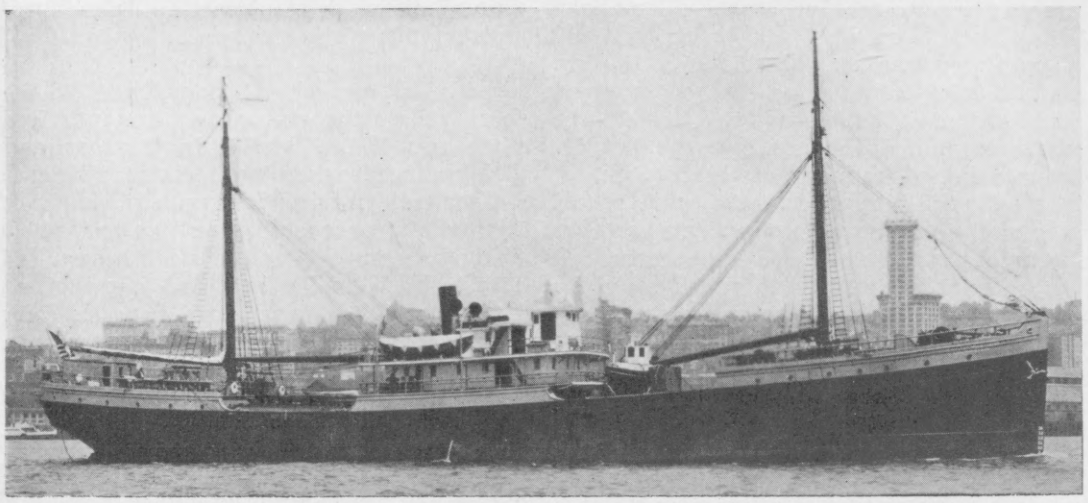
The engines are standard M. A. N. full Diesel air injection type submarine type Diesels. The piston diameter is 20.87 in. with 20.87 in. stroke. Each engine has ten working cylinders, designed for a maximum of 3000 b.hp. at 390 r.p.m. when operating in the war ships but cut down to a steady load of 1660 b.hp. at 230 r.p.m. in merchant ships. The pitch diameter of the pinion is 31.5 in., of the gear 85 in., number of teeth 167 and 452 respectively, 47.2 in. face, 5.31 D.P.

The drives were built by Blohm & Voss, Hamburg, and follow the lines laid down in the JAMES TIMPSON and LIBBY MAINE, from which they differ only by the method of coupling engine and gear unit. The engine crank shaft is connected to the pinion in quite an original manner. The pinion is bored hollow and a tube-like extension or quillshaft attached to its free end. A torsion shaft about 23 ft. long and rigidly connected to the crank shaft runs through pinion and quill shaft being attached to the latter's end. Thus a flexible connection is interposed between engine and gear unit. The crank shaft is fitted with a very heavy fly wheel and a second fly wheel is fitted to the end of the pinion shaft.

It has been the opinion of many prominent engineering authorities that the connection of two or more oil engines to one common reduction gear might have disastrous results due to the irregular torque of the oil engines. The Falk Corporation having the experience of years of successful gear building and especially the experience with about 3,500,000 b.hp. successful marine turbine reduction gears back of them did not agree with this opinion and decided to build a large geared oil engine layout in order to prove that the solution of problems connected with this kind of drive could be found.

The maximum number of engines that can be coupled in a simple way to one single slow speed gear is four and the writer worked out plans for such a combination as early as 1919, according to which his company built a 2200 b.hp. full reversible marine engine.

This engine consists of four unit engines of four cylinders each, the crank shafts of which are coupled to the pinion by means of Falk-Bibby couplings.



Pioneer gear driven motorship Libby Maine, 9 years in service

Characteristics of Falk Engine and Drive

Number of cylinders	16
Cylinder diameter	19 in.
Stroke	28 in.
Speed	200 r.p.m.
Piston speed	935 ft. per min.
Brake mean pressure	68.2 lb. per sq. in.
Propeller speed	90 r.p.m.
Number of teeth, pinions	71
Number of teeth, gears	159
Pitch circle diameter, pinions	35½ in.
Pitch circle diameter, gears	79½ in.
Net face of teeth	26 in.
D.P.	2
Lubrication of gear teeth	Semi-fluid comp.
Piston cooling	None

The oil engines for this unit, the first built by The Falk Corporation, have apparently a low rating. Today this same engine would operate with a brake mean of 85 lb. per sq. in. and run a somewhat higher piston speed so that the unit would develop 3000 b.hp. instead of 2200 b.hp.

This engine was not installed in a ship but used to supply the motive power for The Falk Corporation shops. It has been in continuous and very successful operation for more than 4 years and a very complete description of it may be found in a special supplement to MOTORSHIP for May, 1923.

In November, 1924, the Blohm & Voss Co. completed another geared ship, twin-screw ms. MONTE SARMIENTO, which was followed several months later by a sister ship ms. MONTE OLIVIA. In the propelling machinery of the two ships the same principle of gearing a number of engine units is used as was first realized by The Falk Corporation. The two ships are combined passenger and freight carriers of 13,628 gross tons apiece with a length of 523.9 ft. Each of their twin propellers is driven by a pair of 6-cylinder Diesels of a combined output of 3500 b.hp., the total power of each ship being 7000 b.hp.

Ms. Monte Sarmiento Engines

Number of cylinders	12
Cylinder diameter	23.62 in.
Stroke	27.56 in.
Speed	216 r.p.m.
Piston speed	990 ft. per min.
Brake mean pressure	88 lb. per sq. in.
Propeller speed	77 r.p.m.
Number of teeth, pinions	124
Number of teeth, gears	348
Pitch circle diameter, pinions	32.22 in.
Pitch circle diameter, gears	90.36 in.
Diametral pitch	3.85
Net face of teeth	47.25 in.
Lubrication of gear teeth	Lub. oil
Piston cooling	Lub. oil

The connection between engines and pinions was originally effected by means of the same quill shaft arrangement which had been successful on the single drives of the HAVELLAND type ships, in connection with a coupling. These drives have not been successful and were later replaced by rigid connections, which are now functioning well.

[*Continued on page* 205]

* Diesel Engineer, Falk Corporation, Milwaukee, Wis.

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Application of Geared Marine Diesels

[*Continued from page* 200]

Very heavy fly wheels have been fitted on the engines and brakes provided on them in order to permit quick stopping when maneuvering.

A short time later a fourth HAVELLAND type ship named VRIESLAND was built by the same yard, but in this ship the twin screw arrangement was abandoned and replaced by single screw propulsion. In this case the propelling machinery consists of a pair of 10-cylinder engines of exactly the same type as in the older ships, but these engines are geared to one propeller in exactly the same way as in the case of the MONTE SARMIENTO engines. The propelling power transmitted through the low speed gear is 4000 b.hp. This ship was commissioned during 1926. Another expression of the idea is represented by the introduction of the hydraulic clutch invented by Dr. Foettinger. The first installation of this kind was made in the ms. VULCAN, commissioned in July, 1924. This was a 2000-dwt. ship having a length of 229.7 ft., a beam of 36 ft., and a load draft of 16.25 ft., and two 6-cylinder engines of 310 b.hp. each at 300 r.p.m., operating the propeller through the reduction gear at a speed of 85 r.p.m.

Ms. DUISBURG of 9500 dwt. capacity, commissioned in July, 1925, and her sister ship RENSBURG, are both equipped with a Foettinger geared drive. The propelling machinery consists of a pair of 8-cylinder M. A. N. type engines. The total power developed is 4100 b.hp., with an engine speed of 210 r.p.m., and a propeller speed of 79 r.p.m.

In any consideration of the problems connected with twin geared drive, it is at once apparent that the mass of the flywheels on the unit engines should not be more than absolutely necessary to insure regular operation at low speeds. There are conditions connected with the problem of the torsional vibrations in the drive which may make it necessary to increase the flywheel mass above this limit but the tendency should always be to keep the flywheel weight down as much as possible.

There is no danger than even with an exceedingly small flywheel the smoothness of the torque delivered to the propeller will be endangered as can be proven very convincingly.

Torsiograms No. 1, 2 and 3 are taken on the Falk-geared four-unit engine described in the Falk supplement of MOTORSHIP. They show the variations of the speed of a point at the circumference of three different parts of the shafting. They are all enlarged three times so that the actual movements are only one-third of the recorded ones.

Torsiogram No. 1 was taken on the crank shaft of one end of the engine right next to the flywheel. The fluctuations are quite sizable, which is a consequence of the small inertia of the flywheels, and they are transmitted in full amount to the pinion of the reduction gear which in turn transmits them to the low speed gear at the oscillation point of the pitch circle, the arcs of the fluctuations measured on the peripheries of the pinion and gear being, of course, the same. It follows that the angle of movement on the gear must be smaller in proportion to the gear ratio.

Diagram No. 1 explains this and in order to visualize the great difference of the angular movement, in diagram No. 2, the pinion has been placed over the center of the gear, the length of oscillation being in both instances the same and it is plainly evident that the gear shaft fluctuates less in proportion to the gear ratio. The correctness of this reasoning is proven by Torsiogram No. 3 which was taken at the low speed gear flange, the engines operating under the exact condition as mentioned by Torsiogram No. 1. In both cases only two of the four engines were connected to the gear unit and the cranks of the two engines were set parallel. As soon as all four engines were connected (two pairs of cranks set at right angles to the other two) Torsiogram No. 3 was obtained at the low speed gear flange. The load on the generator was 2200 b.hp. and the speed of the low speed shaft 90 r.p.m. The torsiogram is again enlarged three times and the smoothness of the movement is quite surprising. The crank shaft diameter is 11 in., the gear shaft diameter 14 in.

It is usually assumed that a geared steam turbine delivers a perfectly smooth torque and that, therefore, the line shaft of such an installation is entirely free from speed and accordingly torque vibrations. This is a mistake. The torque fluctuations due to the uneven resisting moment of the propeller are many times larger than those disclosed in Torsiograms Nos. 2 and 3. These propeller fluctuations occur three times per revolution in a three-bladed and four times in a four-bladed propeller. Torsiogram No. 4 was taken right at the low speed gear flange and No. 5 right ahead of the tail shaft of one of the two propeller drives on a big ore carrier, each propeller being operated by a 2500 b.hp. compound high speed steam turbine.

It is evident that the fluctuations at the gear flange are only slightly less than those at the Falk reduction gear, whereas those of the propeller are much more intensive. If this propeller periodicity coincides with a natural torsional frequency of the complete rotating system, a most serious condition will exist. There are other conditions inherent to high speed gear drives which may lead to similar very serious trouble. An investigation carried out on a number of steam turbine driven ships has disclosed the fact that such conditions actually existed at certain speeds on some of the ships investigated. These conditions do not exist on oil engine drives due to their very much lower speed.

Having thus established the fact that the geared oil engine drive delivers its torque with a smoothness comparable to that of geared steam turbine drives, it follows that the rules for dimensioning the line and tail shafts of turbine drives should be applied to them. It is gratifying to state that in the first case where a conversion of a 2600 b.hp. marine steam turbine installation to geared oil engine propulsion came under the consideration of the American Bureau of Shipping, this body, after a careful study of all conditions involved (during which the Torsiograms Nos. 1 to 3 were taken) approved the retaining of the old 12½ in. line shaft of the turbine drive for the geared oil engine installation.

The quill shaft drives fitted in the single engine reduction gears of the ms. HAVELLAND, MUENSTERLAND and VOGTLAND have been quite successful but when these drives were fitted on the twin engine drive of the ms. MONTE SARMIENTO an unexpected development presented itself. I understand that when the engine was being started on compressed air, and was still at low speed, torsional oscillations of such severity occurred that the gear drive was actually endangered and these oscillations were not of the type usually understood by this name which means that at the critical speed of rotation a natural frequency of the rotating system or one of its overtones coincides with an impulse frequency of the engine. The explanation for the trouble was found in the slight discrepancies between the exact torque impulses coming from both engines. The torque impulses are propagated in the steel of the shafting with the velocity of sound, irrespective of the diameter of the shaft and although this velocity is very high, yet, due to the great length of the torsion shaft arrangement an appreciable discrepancy of torque phase may develop at the gear

Fig.1 Torsiogram from Crankshaft, next to flywheel on Power House layout

Fig.2 Taken from the same layout

Fig.3 Taken at Low Speed Gear Flange, Speed 90 r.p.m.

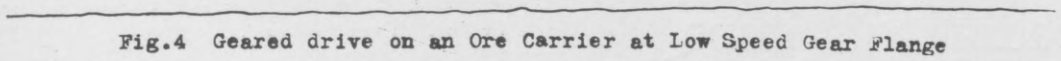

Fig.4 Geared drive on an Ore Carrier at Low Speed Gear Flange

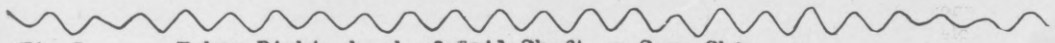

Fig.5 Taken Right ahead of Tail Shaft on Same Ship

Torsiograms taken on a Falk-geared 4-unit Diesel layout

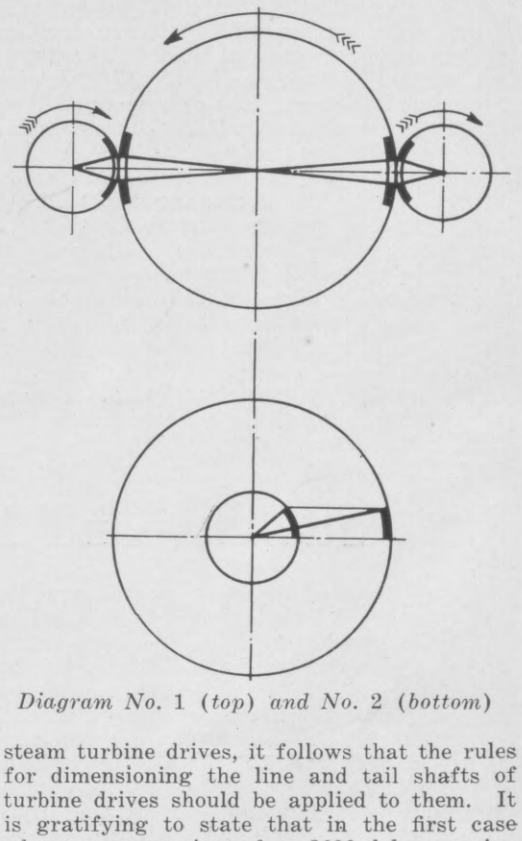

Diagram No. 1 (top) and No. 2 (bottom)

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teeth. This condition has led to the abandoning of the torsion shaft drive in the installation of a rigid connection which is exceedingly short and therefore free from this peculiar trouble. It may be noted that this phenomenon only appeared at low speeds.

The 2200 b.hp. Falk engine has been started and shut down many hundreds of times. For experimental purposes it has been operated at all speeds down to as low as possible. In one instance the machinery of the generator made it necessary to run the engine for three full working days successively at a speed of 18 r.p.m., but the phenomenon observed on the Blohm & Voss engine has never appeared. The reason why the two engines behaved so much different in this respect is the fact that in the Falk engine Falk-Bibby resilient couplings are fitted to transmit the crank shaft torque to the gear pinion.

Gears for oil engine drives differ radically from steam turbine drives. Steam turbines deliver an even torque at high speed whereas oil engines deliver a continually varying torque at low speed. The experience with reduction gears which The Falk Corporation has built for pipe line dredges in which the fluctuating power of the oil engine has to be transmitted to the fluctuating resistance of the pump has proven conclusively that the fluctuation of the torque has no influence at all on the life of the gear teeth.

Experience with gears on all motorships so fitted would appear to indicate that there is a great deal to be said in favor of this form of drive.

The earlier gear units for ms. JAMES TIMPSON were particularly satisfactory. On inquiry, the following wire was received from the operators of ms. LIBBY MAINE: "Gears still running satisfactorily, never been compelled slow down engine account gear. Due, however, slight hogging wooden hull port reduction gear showed some wear and were compelled replace high speed reduction gear. Think this trouble would not occur iron hull. Our opinion Falk Reduction Gears are complete success." This telegram was received on Sept. 30, 1926, the ship had been 9½ years in service.

A third ship with twin geared oil engines, which is to be the sister ship to ms. MONTE SARMIENTO, has just been ordered by the Hamburg-South American Line. When they placed this order they stated that the success of the geared engine installation on the first two ships has been excellent. There was no appreciable wear found on the gear teeth.

The men in charge of the engine departments of the two big lines, Hamburg-American and Hamburg-S. American Co., which operate these geared motorships, are on record with some very important statements in connection with these drives.

The gears and engines of the oldest of their geared oil engine ships the HAVELLAND have been thoroughly inspected after 3 years of continuous operation and both were found in perfect condition with practically no wear on the gear teeth, the pistons and the liners.

They are of the opinion that piston cooling is in some cases likely to be troublesome, and in this connection it should be remembered that with gear drive piston dimensions can be kept so small that piston cooling can be dispensed with.

Stability and Loading of Ships

THE first and tentative report issued by the Special Committee on the Stability and Loading of Ships appointed by the American Marine Standards Committee shows that this committee, which is fully representative of the best interests of this country, is convinced of the necessity for the government control of ship stability. Their report outlines the vast amount of ground they have covered preparatory to the accepting of the advisability of such control, and finally reviews the tentative measures which would adequately admit of such control being put into practice. In publishing the report the committee have acted with commendable breadth of vision by requesting those to whom the report has been forwarded to submit any criticism of a constructive nature which may occur to them for consideration and ultimate assistance. Needless to say we fully endorse this policy and would welcome in our columns letters from readers dealing with such questions of stability as are brought out peculiarly by the motorship.

Stability is one of the several peculiar subjects embraced by Naval Architecture. It has a beautiful theory, it has definite applications, but its commercial value is a curious quantity. The more stability a vessel has we cannot say she is thereby a better profit earner; and if she happens to have no stability at all (when upright) it by no means follows that she will not be a lucrative source of income to the owner. What then is stability worth to the shipowner, to the passenger or to the crew? Do we find it such a tangible possession or urgent necessity that there are constant public outcries on the part of the interested parties for more of it? We hardly think so.

A shipowner wants his ship to float and to float upright. Countless generations of shipbuilders have taught themselves to build ships which will satisfy this requirement. In a few rare cases they have failed, in a few more cases the shipowner has failed rightly to use an otherwise satisfactory vessel and in a few further cases "Acts of God" have intervened to bring home to us the final authority on this subject.

Viewing the subject broadly we can therefore conclude that without any legal compunction whatsoever the vast majority of ships are stable. The shipowner would never dream of ordering an unstable ship neither would a shipbuilder, knowingly, build one. A shipowner may however like a cheap ship or one that loads deeply; and to limit this pardonable avarice the community arms itself and regulations are drawn up and imposed. On the question of stability, the community can hardly be said to have definitely armed itself.

There is one point on which we might offer criticism on the report. The committee publish a most exhaustive bibliography of the literature of the subject available in the English language. A study of this literature has certainly enabled the committee to reflect in their findings the mass of technical opinion behind this literature. In restricting their survey to the English language the committee have neglected the information and perspective which can be gained by a study of the French and German literature of the subject. After all, stability is a subject treated very passively by English speaking peoples. In France, on the other hand, it has always been a burning subject from the point of view of theory; and in Germany similarly a subject of perennial interest, but chiefly from the practical point of view. We recommend the study of the German literature to the committee since in recent years many valuable contributions to our knowledge of the subject have emanated from German Naval Architects. For example, we would instance Dahlmann's recent work on the practicability of inclining vessels at sea and even in port. Dahlmann showed by means of a continuously recording pendulum the practical impossibility of getting results of any reasonable accuracy by this method. This in itself is of importance in view of the committee's proposal to control metacentric height. Further we would instance a recent publication by Benjamin, whose reputation on this subject is international. Benjamin has succeeded more than any other investigator to our knowledge in showing that initial metacentric height is no sufficiently general criterion of a vessel's stability. Benjamin shows that the most satisfactory criterion is the maximum righting lever and the angle at which it occurs. This he substantiates by investigating the percentage loss in dynamical stability over a range of keel for any given initial angle of list. He finds that initial metacentric height has indeed very little influence upon this percentage loss; and his work probably explains why the profession as a whole has given so little concerted action to the establishing of regulations for minimum metacentric height. It would appear that as freeboard is the most important factor in determining a vessel's maximum stability, and if this in itself is a subject of regulation, that the stability problem may for the vast majority of cases be regarded as definitely solved. When freeboard is to standard, it would seem that a simultaneous regulation for initial instability is not a requirement but is rather an advice.

A lot of highly polished brass on a dirty engine fools the superintending engineer just like a clean collar around a dirty neck would fool you.

Letting the engine run until it stops is not so good. Better shut it down sooner and make it run longer.

Our idea of wasted energy is to use up a tank of air to turn an engine until the fuel pumps start injection instead of priming up the fuel valves by hand.

A. B. N.

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